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DESIGN CRITERIA FOR MICROBIOLOGICAL FACILITIES AT FORT DETRICK. VOLUME II. DESIGN CRITERIA

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DESIGN CRITERIA FOR MICROBIOLOGICAL FACILITIES AT FORT DETRICK

VOLUME II. DESIGN CRITERIA

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ABSTRACT

This two-volume series serves as guidance to management and to architects and engineers engaged in facility design at Fort Detrick. Volume II is intended primarily for use by the latter in designing new or modified microbiological facilities for Fort Detrick. It is divided into six sections, corresponding to the normal division of design work: architectural; heating, ventilation, and air-conditioning; piping; equipment and accessories; electrical; and instrumentation and controls. Each section is designed to be largely self-contained for the use of the individual specialists involved. A detailed Table of Contents, an alphabetical Subject Index, numerous illustrations, a Glossary, and supporting appendixes also are included.

FOREWORD

This is Volume II of a two-volume Manual of Design Criteria, based mainly on biological safety considerations. It has been prepared for the use of architect-engineers in designing new or modified microbiological facilities for Fort Detrick. Volume II is divided into six sections, corresponding to the normal division of design work in an engineering office. Each section is addressed to the specialist in a given field and is largely self-contained, so that he may employ it without having to read the other sections except as directed to them by cross-references.

This manual is not intended to duplicate standards and criteria normally possessed by the architect-engineer. However, some information on Fort Detrick design practices not related to safety appears at the end of most of the individual sections. Finally, the Guide Specifications and Engineering Manual of the Corps of Engineers, Department of the Army, are to be used in the design and preparation of plans and specifications to the extent applicable.

This manual supersedes the manual "Technical Requirements for the Design of Bacteriological Facilities, Fort Detrick, Maryland" dated 1 May 1961, which in turn superseded a manual prepared initially in 1952.

An alphabetical Subject Index at the front of this volume is printed on yellow paper. A detailed Table of Contents (on yellow paper), including a list of plates, appears at the front of each section. The plates are printed on blue paper and are inserted at the back of the individual sections to which they are related. A complete list of plates precedes the subject index. A glossary (on yellow paper) follows Section 6, and is followed by the appendixes (on white paper).

Volume 1, which is bound separately, is entitled "Introduction to Design Criteria for Microbiological Facilities, Fort Detrick." While providing a general background for the specialized users of Volume II, it is intended primarily to be useful to readers with an overall viewpoint, such as management personnel at Fort Detrick, or their counterparts, who may be concerned with the broad planning of microbiological facilities. Volume 1 includes a brief description of existing Fort Detrick facilities, a discussion of safety philosophy, and some representative construction cost data.

It is intended that Volume II will be brought up to date from time to time. Revised pages for addition or substitution will be furnished to each manual holder.

Suggestions or comments regarding these biological safety criteria, based on actual experience, are invited, and should be sent to the Technical Engineering Division at Fort Detrick.

TABLE OF CONTENTS

LIST OF PLATES

The plates, on blue paper, will be found at the end of the individual section to which they are related.

Plate No.

Text Reference Page

Appendix B. MICROBIAL DECONTAMINATION

SUBJECT INDEX

* Underlining indicates principal reference.

4/70

SECTION 1 - ARCHITECTURAL AND STRUCTURAL

TABLE OF CONTENTS

LIST OF PLATES

2/66

SECTION 1

ARCHITECTURAL AND STRUCTURAL

1-00 INTRODUCTION

A. Scope

This section is addressed primarily to those architect-engineering personnel concerned specifically with the architectural and structural engineering and design of microbiological facilities at Fort Detrick. It applies to new facilities, and to modifications and additions to existing facilities. Most of the section deals with architectural features, and a much smaller part with structural.

We state here, as in every section, that the purpose of this manual is to present special design criteria based primarily on biological safety considerations. It is not intended to duplicate the fund of standards and criteria normally possessed by the architect-engineer. However, a sub-section of Fort Detrick Design Practices not related to safety considerations is given at the end of this section. In addition, Appendix A lists a number of Fort Detrick Purchase Descriptions and Specifications which may be obtained from the Contracting Officer.

As described in Volume 1, Fort Detrick contains a variety of facilities, such as laboratories, pilot plants, test chambers, filling lines, storage areas and others. This manual presents the criteria that all of these facilities have in common. To avoid vagueness, many of the criteria are stated in terms of laboratory buildings, but this should not be taken to mean that they are not generally applicable.

With some exceptions, the requirements peculiar to each type of facility are not covered in this manual.

B. Conversions and Modifications

The application of the criteria presented here to the design of new facilities generally will be straightforward. However, many projects involve the conversion or modification of existing facilities. Since these facilities were built there have been changes in the criteria, based on technical innovations or operating experience. As a result it is important for the designer of such modifications to exercise judgment and flexibility in applying the new criteria. Some of the potential problems will be resolved by the specific Contract Scope of Work for the individual project, or by other guidance provided by the Government.

C. Organization of Section 1

The remainder of this section is divided into the following main

sub-sections:

1. Layout and traffic
2. Non-contaminated rooms
3. Contaminated rooms
4. Building structure
5. Architectural components
6. Special materials of construction
7. Required laboratory equipment
8. Fort Detrick design practices

1-01 LAYOUT AND TRAFFIC

A. Principles of Control

1. Each building is divided into contaminated and non-contaminated areas, and the contaminated area is sub-divided into areas of different degrees of contamination.

2. Barriers such as air locks, sterilizers, disinfectant showers, and ultraviolet installations are provided between contaminated and non-contaminated areas, and between areas of different degree of contamination.

3. Materials are decontaminated and personnel shower before leaving contaminated areas.

4. For the protection of laboratory experiments, work areas are protected from being contaminated by extraneous organisms or dust particles.

5. Materials of construction, surface finishes, and design features are selected for ease and effectiveness of decontamination and to provide effective barriers.

B. Illustrative Layout: Plate No. 1.1 is a layout which illustrates many of the features described in sub-sections 1-01, 1-02 and 1-03; however, there is no requirement that a building have all the features shown.

C. Entrances

1. Personnel Entrance

a. All building personnel and visitors (not including service deliveries) enter at a main entrance door and pass through a vestibule into the reception area. Entry to the contaminated area is only through change rooms (see 1-01 D below). Visitors check in at the main office, which is adjacent to the change room entrance.

b. The entrance corridor has provision for a sign-in and

sign-out board and a building directory.

2. Service Entrance

a. An exterior service entrance shall be provided for receiving laboratory supplies, clean laundry, clean animals, and animal feed and for the removal of soiled laundry, cage litter, and the like after it has been sterilized. The area immediately inside of the service entrance shall be kept clear of other equipment inasmuch as all bulky items will be brought into the building at this point.

b. At the service entrance there shall be a non-contaminated receiving and storage area separated from the contaminated portion of the building by an ultraviolet air lock. In some instances one room may serve both purposes; in other instances separate rooms will be needed for receiving and storage, respectively. The receiving area should include space for feed storage, cage bedding, cage washer handling, etc.

c. To move supplies into the contaminated area, they are placed in the U.V. air lock. The supplies are then removed from the air lock by personnel working on the contaminated side. The thru-the-wall bulk sterilizers (see paragraph e immediately below) are sometimes used as an air lock to pass material from the non-contaminated to the contaminated side.

d. No personnel traffic through the air lock, in either direction, is permitted. No passage of material through the air lock from the contaminated side to the non-contaminated side is permitted except for special cases where large objects have been decontaminated within the air lock itself.

e. Adjoining the non-contaminated receiving area, or the non-contaminated corridor serving it, but separated by a solid partition shall be a contaminated receiving room. Between this room and the non-contaminated receiving area there shall be a thru-the-wall double-door autoclave large enough for 32-gallon refuse cans, and a double-door gas sterilizer for apparatus which needs to be decontaminated with gas before being sent out of the building. See 4-06 B, EQUIPMENT, for sterilizer requirements.

f. Alongside the double-door autoclave and gas (ethylene oxide) sterilizer which project through the common wall of the non-contaminated and contaminated service rooms, there shall be a viewing window (at least 24 x 36 inches) with a plastic speaking diaphragm as described in 1-05 F for communicating with the non-contaminated service or storeroom.

g. A room or space directly accessible from the service entrance shall be provided for holding clean animals, clean cages, or other clean materials.

3. Access to Waste Collection Treatment Rooms: Access to the liquid waste collection treatment room is from the contaminated area within the building, through a standard ultraviolet air lock as described in subsection 5-03 B, ELECTRICAL (see also 3-04 1, PIPING).

4. Access to Utility Rooms

a. Direct access shall be provided from exterior to utility rooms by means of double-doors (see 1-05 A.12).

b. In addition to the solid doors, utility room exterior doorways should be provided with doors of woven wire mesh set in small channel iron frames to prevent unauthorized access to electrical equipment therein and to provide a means of ventilation when necessary. These doors shall be provided with master keyed locks as specified for exterior doors.

5. Access to Attic: In addition to the required emergency exits, access to and from attic spaces shall be provided in accordance with the following:

a. Normal access shall be provided directly from exterior of building to attic space by interior stairways in the non-contaminated area.

b. Access shall be provided from attic space to exterior of building to permit removal of large equipment. A monorail system of rated capacity shall be provided above the openings to facilitate this work.

6. Access to Roofs: Access from building interior to roofs shall be provided as directed by the Government.

7. Outside Stairs and Fire Escapes: There shall be no outside stairways touching the ground. Fire escape stairways shall be sufficiently elevated from the ground to prevent access to roofs or attics by rodents.

D. Change Rooms

1. Typical Arrangement: A typical arrangement for change rooms is shown on Plate No. 1.2.

Personnel assigned to work in the contaminated laboratories are required to enter the clean change room from the building's non-contaminated corridor and change from their street clothing to laboratory clothing prior to entering the contaminated laboratory area. (These same locker and toilet facilities are also used by the personnel assigned to work in the clean offices and non-contaminated laboratories). After having changed to laboratory clothing, the laboratory personnel then enter the contaminated laboratory area through an ultraviolet air lock and then through the other toilet and change room serving the contaminated laboratories. Travel communication from the change room on the contaminated side to the locker and toilet room on the clean side is not permitted

without first discarding all laboratory clothing and placing it in ultraviolet-shielded discard clothing racks (see Plates No. 1.3 and 1.4) provided in the contaminated change rooms, and then showering.

2. Locker Room Equipment: Locker rooms or corridors on the non-contaminated side of change rooms shall have racks for overcoats. The non-contaminated change room shall have clothing lockers, shelves for clean clothing, shoe racks, benches for seating, and space for a clean laundry bag. The contaminated change room shall have clothing hooks, U.V. shoe rack (see Plate No. 1.5), U.V. clothing discard rack, and benches for seating. In any building in which ticks will be studied, the contaminated change room shall have a full-length mirror.

3. Ventilated Suit Area: Personnel access from a less contaminated area to a ventilated suit area (see 1-03 B, below), shall be through change room and decontamination facilities arranged in the following order: a room for the personnel to change from their laboratory clothing to other under clothing worn with the ventilated suits; a U.V. air lock or U.V. door barrier depending upon the operations; a suit dressing room for the storage, dressing, and undressing of ventilated suits; a room or space for drying the ventilated suits; and a disinfectant shower compartment. Local toilet facilities are not provided for these smaller change facilities.

E. Air Locks

1. Use: U.V. air locks, as illustrated on Plates No. 1.6 and 1.7, shall be provided in corridors where separation between non-contaminated and contaminated areas is required. Typical examples are: between non-contaminated service receiving area (or adjoining corridor) and contaminated service receiving room, and between the non-contaminated and contaminated side of the change rooms. A U.V. air lock is required on the less contaminated side of the disinfectant shower leading to a ventilated suit area.

2. Length: The length of air locks may vary depending upon the dimensions of the traffic, such as carts and cage racks to be handled, in conjunction with the requirement that only one door shall be open at any time. Air locks at service entrances, or between non-contaminated and contaminated receiving rooms (or corridors serving these rooms) shall be ten (10) feet minimum in length inside.

3. Doors: Doors to air locks, unless otherwise directed, shall be single swing, 42 inches wide, equipped with automatic door closer, an armor plate guard as described in 1-05 A.6 and Plate No. 1.14, and a standard size plastic speaking diaphragm as specified under sub-section 1-05 F.

4. U.V. Barriers: Unless otherwise directed, air locks shall have an ultraviolet door-barrier (see Plate No. 1.8) at the contaminated end and ultraviolet ceiling fixtures conforming with the requirements of

sub-section 5-03, ELECTRICAL. The U.V. door barrier may be omitted for air locks serving rooms (other than pilot plant units) in which all the equipment is housed in gastight cabinets.

5. Floor Drainage: Air lock floors shall slope toward the more contaminated rooms or corridor for drainage purposes.

1-02 NON-CONTAMINATED ROOMS

A. List of Rooms

1. The main non-contaminated area will include some or all of the following rooms:

Entrance corridor
Reception area
Change room(s)
Main office
Laboratory Director's office
Other offices
Conference rooms and vaults
Lunch room
Receiving and storage
Cage washing
Animal holding
Glassware washing
Laboratories
Janitor closets
Connecting corridors
Lavatory

2. Other non-contaminated areas, which in general will be separate from the main area, include the following:

Attic (for HV&AC and other equipment)
Utility equipment room(s)

B. Requirements

1. Main Office: The main office has provision for storage of records, files, and photographs, and controls for the building's communications.

2. Office Space: The amount of space for non-contaminated offices and laboratories may be varied according to need.

3. Viewing Panels and Speaking Diaphragms

a. Except for a sealed crash door, no communicating door is permitted directly from the non-contaminated to the contaminated areas. Instead, a viewing panel and a speaking diaphragm shall be provided in the corridor partition separating these areas (see 1-05 F and Plate No. 1.1).

b. Viewing panels and speaking diaphragms are required between the non-contaminated secretarial offices and the contaminated offices or contaminated corridor.

4. Decontamination of Papers, etc.: Between the non-contaminated offices and the contaminated offices or contaminated corridor there shall be a single page decontamination U.V. Chamber (see Fort Detrick Drawing No. F-93-1-6714), and a gas sterilizer (see Plate No. 4.13) for overnight decontamination of books and other articles.

5. Lunch Room: The lunch room should have a refrigerator and, where feasible, a kitchenette unit for meal preparation.

6. Conference Rooms and Vaults: The Government shall be consulted in the design of all conference rooms and vaults.

7. Non-Contaminated Animal Holding: A room for holding clean animals, clean cages, and other clean materials shall be provided directly accessible from the non-contaminated receiving service corridor.

8. Glassware Washing Room

a. The glassware washing room may be centrally located within the contaminated area of the laboratory rooms, or there may be one glassware washing room in the non-contaminated area to serve one or several contaminated laboratory suites that are isolated from each other by air locks and non-contaminated corridors. An architectural-engineering study should be made to determine which is preferable. In general, the larger the number of contaminated laboratory suites, the more economical it will be to have one non-contaminated glassware washing center to serve all of them.

b. All laboratory glassware should be sterilized before being removed from the laboratory rooms for washing in the glassware washing room. Provision shall be made for the storage of cleaned laboratory glassware.

c. In sizing the glassware washing room, consideration should be given to the increasing use of disposable glassware, hypodermic syringes, and plastic items.

9. Cage Washing Room

a. The cage washing room is better located in the non-contaminated area adjacent to the contaminated animal rooms. A less desirable location is adjacent to the animal rooms in a contaminated area. In either case, all cages from the contaminated animal rooms shall be autoclaved before contaminated animal excreta and bedding are removed, and before they enter a non-contaminated corridor or the cage washing room (see Plates No. 1.9 and 1.10).

b. An architectural-engineering study should be made to determine whether the cage washing is better located in the contaminated area or in the non-contaminated area. In general, the more contaminated laboratory suites as described in the preceding paragraph that there are in a building, the more economical it will be to have one non-contaminated cage washing center to serve all of them.

c. The cages may move into the cage washing room through an inner contaminated corridor (see 1-03 C.3 below) terminating in a double-door thru-the-wall autoclave so located that there is a nearby conveniently located viewing window and plastic speaking diaphragm (see 1-05 F) serving persons stationed at both ends of the autoclave. The larger and more numerous the animals, the more desirable it is to avoid using the main corridor to transport contaminated cages or dead animals to the double-door autoclave. If the main corridor is used for contaminated cage transport, design shall seek to place all animal rooms at one end or portion of the contaminated area so that one set of double doors, or a corridor-wide air lock, can separate the animal room area from the laboratory area. A transport chamber such as that shown in Plate 1.9 will be used to transport contaminated cages from the animal room to the autoclave when the movement is through the main corridor. Clean cages will be returned to the contaminated animal rooms through a non-contaminated corridor, or through a U.V. air lock, or through the main contaminated corridor, or through a combination of these. Use of the aforementioned inner contaminated corridor to transport clean cages is undesirable.

d. Space shall be provided for assembling clean cages, for testing cages when required by the using service, and for storing clean cages, and shall be located adjoining the cage washing room and convenient to the animal holding rooms.

10. Utility Rooms

a. Equipment rooms, machinery rooms, plenum chambers, and all machinery installation areas shall be designed to provide easy access to mechanical equipment to be installed therein, for the purpose of servicing, repairing, and/or replacement. Doors, scuttles, and access panels to machinery areas shall be adequate in size and location.

b. Equipment arrangement within the respective areas shall allow for space for removal and replacement of large pieces of equipment such as tanks, shell and tube condensers or tube bundles, where such equipment or components are specified.

11. Convertible Rooms: See 1-03 L, below.

1-03 CONTAMINATED ROOMS

A. List of Rooms: The contaminated area will contain some or all of the following rooms:

Corridors
Receiving
Storage
Animal holding
Laboratories
Offices
Conference
Media prep
Glassware washing
Cage washing
Walk-in incubators and refrigerators
Flammable material storage
Waste collection treatment
Special work areas
Janitor closets
Refuse incinerator room

B. Ventilated Suit Areas: Rooms of potentially higher hazard, such as some animal rooms or rooms containing aerosol test chambers, require the wearing of ventilated suits (see Plate No. 1.11), or in some cases ventilated hoods (see Plate No. 1.12), for personnel protection. They shall meet the following requirements.

1. Access: Access is through a U.V. air lock and disinfectant shower (see 1-01 D.3 above).

2. Sealed Partitions: Except for the access (protected by air lock) and the ventilation exhaust (protected by filters) the work space is enclosed in sealed partitions (see 1-05 B.3.c).

3. Decontamination: Any and all contents, once exposed to the interior of the ventilated suit work space, shall be sterilized before they are released to the surrounding environment (whether non-contaminated or of a lower degree of contamination).

4. Ventilation: The ventilated suit area is maintained at a lower pressure with respect to the surrounding area.

C. Animal Holding Rooms

1. Size: In sizing animal holding rooms, consideration shall be given to the location and number of cage racks and cage service cabinets. (See 4-02, EQUIPMENT and Plates No. 4.7, 4.8, and 4.9 for cage racks). Aisle space at least four (4) feet wide should be provided in front of the cage racks.

Allowance shall be made for the general experience that animal holding facilities are frequently undersized.

2. Cage Ventilation: All animal rooms shall be designed to house ventilated, U. V.-irradiated cages, and non-ventilated, non U.V.-irradiated cages. At least one animal room in each contaminated laboratory suite shall be equipped initially with ventilated cages, and the using service shall decide whether more than one animal room shall be so equipped initially. In the other contaminated animal rooms the cage exhaust system may be closed off as specified in 2-05 B.6, HV&AC, and Plate No. 2.2.

3. Inner Corridor: The main corridors serving laboratories shall not be used to transport soiled cages, cage litter, and the like. An inner corridor serving each of the animal holding rooms shall be provided through which cages may be carried to a double-door thru-the-wall sterilizer opening into the cage washing room (see 1-02 B.9). This automatically insures that all cages will be sterilized before being opened to be cleaned by washing.

4. Location: Animal rooms shall be located together in one general area to segregate possible hazardous dusts and to facilitate the handling of infectious materials.

5. Water Supply: The animal rooms shall be provided with at least one 24" x 21" x 10" deep (l.D.) stainless steel sink with stainless steel drainboard and having hot and cold water supply. The sink shall be equipped with a removable cup strainer to collect debris and may be located in the inner corridor if space permits (see also 4-09 A.2, EQUIPMENT).

6. Ventilated Suits: Entrance to animal holding rooms in which personnel must wear ventilated suits shall be through a decontamination compartment (see 1-03 B above). A viewing panel shall be provided in each room where ventilated suits are used.

D. Glassware Washing Room: See 1-02 B.8.

E. Cage Washing Room: See 1-02 B.9.

F. Contaminated Receiving Room: The contaminated receiving room is used for receiving and handling soiled laundry, cage litter, worn-out equipment, and the like. For further information see 1-01 C.2e above.

G. Laboratories

1. All spaces in back of built-in or wall-supported laboratory furniture if not accessible for cleaning must be sealed to prevent the entry of microorganisms (see 1-05 A for caulking compound).

2. For equipment required in all contaminated laboratories see 1-07 below.

3. Adequate space for maintenance and operation of service piping valves shall be provided in all laboratory room layouts.

2/66

H. Walk-In Refrigerators and Incubators

1. General Requirements: Each walk-in refrigerator and incubator shall be a completely pre-fabricated unit (including floor). The finish concrete floor under refrigerators and incubators shall not be depressed. (See Purchase Description listed in Appendix A).

2. Condensate Drain: The drain line for condensate drip from evaporator shall be extended through the floor, not run on top of floor.

3. Doors: See 1-05 A.3.

4. Insulation: Because of the sealed construction, insulation is not required to be non-halogen liberating (see also 4-19, EQUIPMENT).

5. Sealing Crevices: All crevices between the refrigerator or incubator, and the walls and floor of the room, shall be sealed with caulking compound (see 1-06 A).

6. Required Use: See 1-07 E.

7. Other Requirements: See 4-03 and 4-05, EQUIPMENT and 6.05 C and 6-05 D, INSTRUMENTATION.

I. Waste Collection Treatment Room: See 1-01 C.3 and 3-04 1, PIPING.

J. Flammable Material Storage

1. Provision shall be made in all laboratory buildings for a flammable material storage room conforming with the National Board of Fire Underwriters' Requirements for Type "B" inside storage or mixing rooms, and protected with a fixed CO_2 extinguisher system installed in accordance with N.B.F.U. or N.F.P.A. requirements. Approximately one pound of CO_2 is required for each fifteen (15) cubic feet of space. See Plate No. 1.13 for details.

2. Flammable solvents in a total amount up to 50 gallons, in containers not holding more than five (5) gallons each, may be stored in metal cabinets outside of the flammable material storage room. Drawings of an approved cabinet design are available from the Government.

K. Special Work Area: In some laboratories there may be a small work area for glassblowing and preparation of special laboratory equipment or apparatus.

L. Convertibility

1. General: Changing space requirements sometimes make it desirable to convert non-contaminated working space to contaminated space, and vice versa. In general, this will require a substantial modification

project in order to meet the criteria established in this Manual. In isolated cases, it is feasible with relatively simple changes to create "Limited-Use Areas", as defined below.

2. Limited-Use Area: To convert to a "Limited-Use Area", for contaminated or non-contaminated use as the case may be, the following conditions must be met:

a. The area must be located contiguous to a contaminated or non-contaminated area, as the case may be, so that proper access can be provided.

b. The area must have been provided with plugged floor drains (see 3-04 B, PIPING) and capped exhaust duct which shall now be opened for contaminated use, or plugged and capped for non-contaminated use.

c. It must be determined, for contaminated use, that the type of work is such that there will be no appreciable hazard of cross-contamination of the non-contaminated services or ventilation air with which the area is supplied, or of escape of contamination to the non-contaminated area through the walls because the penetrations are not suitably sealed. For non-contaminated use it must be determined that there will be no appreciable hazard of contamination of the limited-use non-contaminated area resulting from its being supplied with contaminated services and ventilation air or the incomplete sealing of the wall between it and the contaminated area.

d. The conversion must be approved by the Government.

1-04 BUILDING STRUCTURE

A. Foundation: Individual footings under columns in interior walls, and footings and/or grade beams under exterior walls, in addition to being on undisturbed soil of suitable bearing, shall be of minimum depth required for rodent control as specified in 1-04 B.

B. Rodent and Vermin Proofing: All man and animal infectious disease laboratory buildings shall be completely rodent-proofed in accordance with criteria established by the U.S. Dept. of Health, Education and Welfare, Public Health Service, Communicable Disease Center, Atlanta, Georgia in its book entitled "Rodent Borne Disease Control Through Rodent Stoppage", dated 1961. This book provides detailed design information which will assist the architect-engineer in the rodent proofing of structures, especially in animal rooms, and storage areas for animal feeding and bedding, that are particularly susceptible to infestation of insects. Additional material is given in "Handbook of Pest Control" by Arnold Mallis, McNair Borland Co. 1964 and in "Destructive and Useful Insects" by C. T. Metcalf, W. P. Flint and R. L. Metcalf, McGraw-Hill, 1962.

C. Structural Frame: The structural frame shall be reinforced concrete or structural steel columns, spandrels, girders, beams, floor and roof slabs. Particular care shall be taken in the design to minimize deflection that might result in cracking of floors, walls or ceilings. Top of structural floor slabs, except basement floor, shall be not less than 3/4 inch below finish floor line (at the low point) to receive applied finish floor conforming with the requirements of paragraph 1-05 C.

D. Fire Resistant Construction: While the added cost of fireproof construction will in general not be justified, fire-resistant materials and construction methods shall be used to the fullest extent practical. Wood and other combustible materials shall be used only with Government approval.

1. Insulation: See 3-06 A, PIPING.

2. Fire Sprinklers: See 3-05 A, PIPING.

E. Corridor Width: The width of main corridors in the building shall be six (6) feet clear minimum. Wider corridors shall be provided when required by special operations.

F. Story Height: A reasonable minimum story height shall be maintained, based on a clear corridor height of eight (8) feet, plus the space required for the air duct system at the top of the corridor, plus the thickness of the floor construction above. The minimum may be exceeded if necessary to accommodate piping and duct work from fume hoods, biological safety cabinets, and aerosol chambers.

G. Suspended Ceilings and Pipe Spaces: To avoid rodent harborages and spaces not easily accessible to decontamination, suspended ceilings and enclosed pipe spaces shall not be used in contaminated areas. Vertical pipe and ducts may be run in open recesses in the corridor or in the corners of laboratory rooms. Piping arrangements shall be such that easy access is possible, and no double rows of piping will be permitted. Pipe tunnels leading from a partial basement utility room may be used for distribution of services in one-story buildings.

H. Floor Loads: Except for specifically heavier design loading requirements, floors shall be designed for a minimum live load of 100 pounds per square foot.

I. Expansion Joints: Expansion joints in walls, floors, and roof shall be provided with a continuous water stop. In addition to the water stop, expansion joints in contaminated areas shall be filled to a depth of 1/2 inch from the interior finish face of wall, floor and ceiling with a two-component rubber-base sealing compound (as specified in 1.06 A).

J. Waterproofing

1. Where Required: The floors in all contaminated areas, and the

floors in all non-contaminated areas that are located above occupied spaces and are subject to washdowns and splashings such as cage washing rooms, clean animal holding rooms, change rooms, showers, and attic utility areas, shall be waterproof construction. The floor and walls of rooms in which waste collection treatment units are located shall be waterproof construction.

2. Method

a. Epoxy-Aggregate Finish Floor: In all areas where epoxy-aggregate finish floor is used, this shall be so applied as to provide a continuous water barrier (see 1-05 C.5 for use and method of installation).

b. Continuous Membrane: All floor slabs on grade in contaminated areas shall be placed on a continuous polyvinyl chloride (PVC) sheet of 6 mils minimum thickness, extended up the wall for 6 inches, with sleeves of same material around all penetrations, sleeves to be sealed to membrane by thermal or solvent fusion (see 1-05 C.6).

c. Attics: Floors in attic utility areas shall be coated with a thin (5-6 mils) epoxy finish.

1-05 ARCHITECTURAL COMPONENTS

A. Doors: See Plate No. 1.14.

1. Single Swinging Doors: Single swinging doors 42 inches wide shall be used in animal rooms, laboratories, store rooms, receiving rooms, air locks, glassware washing rooms, and cage washing rooms. Doors shall swing into the room away from the corridor, except where doors are recessed and the door edge will not project into the corridor. All exit doors shall swing in the direction of exit travel.

2. Speaking Diaphragms: Doors into potentially contaminated rooms, including laboratories, air locks, and contaminated offices, but excluding doors to change rooms, walk-in refrigerators and incubators, and janitor's rooms, are required to have a clear plastic speaking diaphragm set in the door so that the lower edge is 58 inches above the floor. See 1-05 F.3 for details.

3. Viewing Panels: Doors to walk-in refrigerators and incubators shall have a minimum area of 125 square inches of sealed double glass such as "Thermopane" to serve as a viewing panel, with the bottom located 58 inches above the floor.

4. Double Doors: Double doors designed to swing out in the direction of egress are required in chemical laboratories where there is a risk of explosion and fire. Double doors may be used in corridors and in animal rooms for sheep or larger animals, and are recommended at service entrances to building and utility rooms.

5. Sliding Doors: These doors may be used in process areas where large equipment has to be moved, in animal rooms for sheep or larger animals, and elsewhere when space requirements so dictate.

6. Armor Plates: Armor plate of 16-gage type 430 stainless steel four (4) feet high shall be placed on all doors of laboratories, animal rooms, receiving rooms, air locks, glassware washing and cage washing rooms. Armor plate shall be installed on the push side of single swinging doors and on both sides of double-acting doors. This armor plate shall extend over the free-swinging edges of doors into air locks, animal rooms, glassware washing rooms, cage washing rooms, and on all double-acting doors into contaminated areas.

7. Interior Door Construction: Unless otherwise specified, interior wood doors shall be solid core hard wood flush doors where installed in laboratory buildings. Doors to animal holding rooms shall be all-welded flush metal solid wood core doors. Doors to walk-in refrigerators and walk-in incubators shall be metal-clad insulated refrigerator doors.

8. Gastight Doors: Gastight doors shall be constructed of corrosion-resistant steel, hermetically sealed, and shall effect a gastight seal when closed. Door frame shall be of corrosion-resistant steel covering over wood and all joints welded. All hardware should be factory-applied. Use will be individually specified by Government, for applications such as entrance to disinfectant shower from ventilated suit area, in aerosol chambers, and in selected areas of the pilot plant.

9. Automatic Door Closers: Automatic door closers are required on all doors.

10. Entrance Door Controls: Entrance doors from non-contaminated corridors to clean change rooms shall be equipped with pneumatic door closers, as listed for hardward set H2A in sub-section 1-08 D.7.

11. Elevator Doors: Doors of freight elevators shall be arranged to open to the full width of the elevator cab. Doors shall be vertical sliding biparting, motor-operated for automatic opening and closing, and shall be equipped with a safety seal astragal similar to that of the Peelle Company. See also 1-05 C.

12. Emergency Exit Doors: Emergency exit doors (crash doors) leading from contaminated areas to non-contaminated areas and to exterior areas shall be equipped with panic hardware as listed for hardware set H20 in sub-section 1-08 D.7. In addition, a thin panel of cement asbestos board, scored so as to be easily broken, will be attached to the interior of the door frame and sealed at the periphery to be airtight. A sign reading "EMERGENCY EXIT ONLY. CRASH PANEL" shall be painted on the interior or "push" side of the panel. This seal is to be applied by the Government.

13. Exterior Doors: All exterior doors shall be of nonferrous metal

and shall have extruded aluminum or bronze interlocking-type threshold to receive spring-type bronze weatherstripping applied to bottom of doors.

14. Interior Door and Window Frames: Frames for interior doors and viewing panels shall be hollow metal type designed to finish flush with finish wall surface. Joints shall be all welded and finished smooth. Hollow metal frames in masonry partitions shall be filled solid with cement mortar as erection of masonry proceeds.

15. Woven Wire Doors: See 1-01 C.4b.

16. Ultraviolet Door Barriers: Doors from contaminated rooms, spaces, and corriders to air locks shall have ultraviolet lights installed vertically on both jambs of the door frame and horizontally across the head of the door frame on the side opposite from the door swing. See 1-01 E and 5-03, ELECTRICAL for details.

17. Door Hardware: For the selection of hardware for doors, see 1-05 I, "Builders' Hardware".

B. Walls

1. Exterior Walls: Unless otherwise approved at preliminary design phase, exterior walls below grade shall be reinforced concrete and exterior walls above grade shall be of the cavity type (air space between the exterior and the interior sections) masonry wall. In animal rooms and other rooms subject to high humidity the exterior wall shall be insulated and provided with a vapor barrier on the interior section, to avoid condensation. For the selection of finishes on the interior of exterior walls, see sub-section 1-05 B.3.

a. Glass Block Masonry: See 1-05 F.

2. Curbs: Concrete curbs, poured integral with floor and 4 inches high, shall be installed under walls and at door openings of solvent storage rooms, shower stalls and drying spaces, air handling plenum chambers (see 2-10 D, HV&AC), and under walls of animal rooms, and under walls between non-contaminated and contaminated areas. Curbs are installed also around openings in floors at vertical pipe and duct spaces (see 1-05 E). Face of curb shall be flush with face of wall above.

3. Interior Walls and Partitions

a. Masonry Partitions: Unless otherwise specified, non-load-bearing concrete block or light-weight (cinder) block shall be used for all interior partitions and interior wythe of exterior walls. Block finish shall conform to ASTM Specification C-129-59 to provide smooth surface for application of protective coating as specified in 1-06 C.

b. Flush-type Metal: For special applications, flush-type metal partitions and wall paneling (ceiling high) having a corrosion-resistant surface to receive the protective coatings and paint

finishes specified in sub-section 1-06 C may be specified by Government for use as interior partitions and interior finish of exterior walls. Toilet compartments shall be off-the-floor ceiling hung or wall hung type.

e. Sealed Partitions: Partitions separating contaminated and non-contaminated areas, or installed in ventilated suit areas, shall be sealed to prevent any contamination from getting beyond the finish wall surface. This requirement applies for all joints and cracks in the partition including connections at floor, ceiling, door frames, frames at glazed openings, and wherever openings are made in the partition for pipes, ducts, conduits, fasteners and receptacles (see also 1-05 E). A two-component elastic sealing compound (see 1-06 A) shall be used to seal all joints and cracks which are not all-welded.

d. Smooth Finished Concrete Walls: Smooth finished concrete walls with surface resistant to high humidity, high temperature, and decontaminating agents, shall be used for interiors of rooms in which waste collection treatment units are located.

e. Corner Angle Guards: Corner angle guards shall be provided on external corners of walls and partitions in areas where the use of carts and/or mobile racks is contemplated. Guards shall be 10 gage corrosion-resisting steel, size 6" x 6" x 48" high.

f. Protective Coatings: See sub-section 1-06 C for protective coatings on walls.

C. Floors

1. Floors Pitched to Drain: Unless otherwise directed, the top of applied finish floors shall be pitched (1 inch in 12 feet) to floor drains. Floors in rooms having built in laboratory wall tables and cabinets shall be level for a distance of 3 feet out from wall and thence pitched to floor drains. Air lock floors shall pitch toward more contaminated area.

2. Construction Joints: Construction joints and joints around floor drains shall be sealed water tight with a two component sealing compound (see 1-06 A), unless equally effective seal is provided by epoxy floor topping (see 1-05 C.5.c below).

3. Seal Around Penetrations: For seal around pipes, conduits and ducts passing through floors see 1-05 E below.

4. Waterproofing: See sub-sections 1-04 J and 1-05 C.5.c.

5. Epoxy-Aggregate Finish Floor: Epoxy-aggregate floor topping shall be installed in all finished spaces, unless otherwise specified herein below.

a. Epoxy-aggregate topping shall have a minimum thickness of 1/8" (3/32" to 5/32"). Greater thickness (3/16" to 1/4") shall be specified in locations of unusual wear.

b. Epoxy topping shall be furnished, installed, and guaranteed by one and the same flooring contractor, experienced in this type of flooring.

c. Epoxy topping shall be installed in such a manner as to provide a continuous waterproof barrier, including seals, around penetrations and drains, carrying the topping up the sides of curbs, and with the avoidance of feather-edging.

d. The required floor pitch shall be provided in pouring the original structural slab.

e. Epoxy-aggregate topping shall be used for resurfacing damaged or deteriorated floors in areas specified in 1-05 C.5. Where the old concrete is in particularly bad condition, the use of epoxy-aggregate reinforced with glass cloth should be considered.

6. Heavy Duty Cement Finish Floor: Alternative finish for floors in contaminated areas and for floors on grade that are sealed with membrane (see 1-04 J) may be Kalman "absorption process" heavy-duty cement-finish floor.

7. Conductive-type Floors: Conductive-type floors conforming to the requirements of Ordnance Safety Manual ORD M 7-224 shall be used in spaces where risk of explosion may exist (see also 5-06, ELECTRICAL).

8. Vinyl Tile: Vinyl tile floor covering over applied cement finish shall be installed in non-contaminated offices, conference rooms, and corridors. Inlaid vinyl sheet floor covering with a minimum of seams shall be installed in radiological laboratories. (See Radiological Safety Manual, Dec. 1963, 5, f, (1)).

9. Protective Coatings: See 1-06 C.3 for protective coatings on floors.

D. Ceilings

1. Smooth-Finish Concrete: Unless otherwise specified, smooth-finish concrete ceilings shall be used in all contaminated areas.

2. Suspended Ceilings: See 1-04 G.

3. Seals Around Penetrations: See [illegible] E.

4. Lighting Fixtures: Lighting fixtures shall not be recessed in the ceiling (see 5-02 D.2, ELECTRICAL).

5. Protective Coatings: See 1-06 C.3 for protective coatings on ceilings.

70

E. Seals Around Penetrations

1. Floors: Seal shall be provided around all pipes, conduits, instrument tubing, and ducts at each floor level including attic floor through which they pass. See Plates 1.15, 1.16, 1.17, and 1.18 for methods of sealing around pipes, conduits, instrument tubing, and ducts at floors.

2. Walls: Seal shall be provided around all pipes, conduits, instrument tubing, and ducts passing through walls separating non-contaminated and contaminated areas or separating two areas of different levels of contamination. A continuous demarcation line shall be indicated on the floor plan along such walls to distinguish them from other walls. See Plates 1.17, 1.18, 1.19, and 1.20 for methods of sealing around pipes, conduits, instrument tubing, and ducts at walls.

3. Anchoring: Pipes shall not be anchored in walls or floors unless a thorough stress analysis has been made that indicates it can be done safely. Conduit may be anchored in floors and interior walls.

4. Internal Conduit Seal: See 5-02 B.3, ELECTRICAL.

F. Windows

1. Exterior Walls: Glass block masonry openings, with a small double-pane insulating window unit for view panel, are used in exterior walls of all contaminated areas instead of other types of windows. Interior face of glass block shall be smooth. Exterior shall be flush with wall to avoid recesses that attract pigeons. All mortar used in glass block masonry construction, including the joints between glass blocks and metal surfaces, shall be of a type to provide tight, non-shrinking, waterproof, corrosive-resistant joints.

2. Viewing Panels: Clear wire glass viewing panels or windows shall be set in two-component sealing compound (see 1-06 A) in pressed steel frames, with lower edge 58 inches above floor. Minimum size shall be 24 by 36 inches in walls; for doors see Plate 1.14.

a. For required use in walls, see 1-01 C.2f, 1-02 B.3, 1-02 B.9, and 1-03 C.6.

b. For required use in doors, see 1-05 A.3 and Plate No. 1.14.

3. Speaking Diaphragms: Clear plastic speaking diaphragms, similar to those shown in Plate 1.21, shall be installed alongside or in viewing panels in wall, and with lower edge 58 inches above floor in doors. Speaking diaphragms may also be installed in glazed doors. An example is shown on Plate 1.22.

a. For required use in walls, see 1-01 C.2f, 1-02 B.3, 1-02 B.9.

b. For required use in doors, see 1-05 A.2.

G. Elevators and Dumbwaiters

1. Elevator Size, Capacity, and Speed: The minimum elevator platform size shall be 5 x 7 feet; capacity 3500 pounds; speed, 150 feet travel per minute.

2. Doors: To minimize drafts between floors, elevator and dumbwaiter shafts shall have a door at each floor. Elevator doors are covered in 1-05 A.11.

3. U.V. Barriers: For U.V. barriers at elevator and dumbwaiter door openings see 5-03 B, ELECTRICAL.

H. Stairways: See 1-01 C.5 and 1-01 C.7.

I. Builders' Hardware

1. General; There are relatively few special criteria for hardware related to safety considerations, and these are listed below. More extensive information based on conventional requirements will be found in 1-08 D, Fort Detrick Design Practices.

2. Selection of Hardware Sets: Door hardware will be selected by the Government, from the sets listed in 1-08 D.7. Marked floor plans indicating the desired set for each door will be furnished to the architect-engineer.

3. Hospital Pull Arms: Hospital pull arms are used on doors located in contaminated areas with push plates on opposite side.

4. Armor Plates: See 1-05 A.6.

5. Emergency Exit (Crash) Doors: See 1-05 A.12 and 1-08 D.7.

6. Doors to Disinfectant Showers: See 1-05 A.8 and 1-08 D.7.

7. Locks and Latches

a. Unless otherwise specified, locks for all exterior doors and locks on interior doors at either end of air locks shall be type 86A-4 (Fed. Spec FF-H-106a) with Best Universal cylinder #1E64 less core.

b. Unless otherwise specified, locks for interior doors shall be type 85-D-4 (Fed. Spec FF-H-106a) and shall be mastered to Sargent LH 44700 x M.

c. Locks will be provided on interior doors only when specifically designated.

d. Two keys shall be furnished with each cylinder lock for interior doors.

e. Special security requirements, if any, will be indicated by the Government.

1-06 SPECIAL MATERIALS OF CONSTRUCTION

A. Sealing Compounds

1. Construction Grade Compound: This is a rubber-base sealing compound conforming to the requirements of Federal Specification TT-S-00227. The compound shall be applied neatly, using masking tape to protect the finish surface at either side of the joint. This compound is used for all exterior and interior caulking (for example, around floor and wall penetrations, see 1-05 E) except where Aircraft Grade Compound is required (see next item).

2. Aircraft Grade Compound

a. Specification: This is a two-component synthetic polysulfide rubber compound conforming to the requirements of M L-S-8802c, Class B-2.

b. Required Use: This material shall be used for sealing biological safety cabinets and attached equipment, for ventilated suit areas (see 1-03 B), and where very good chemical resistance is required.

c. Tests: Aircraft Grade Compound shall be furnished only by manufacturers whose product has been tested at Fort Detrick and found to be satisfactory. A list of qualified products will be furnished by the Government. The manufacturer will be required to furnish copies of tests conducted to assure physical characteristics as required by MIL-S-8802c, Class B-2, and chemical resistance characteristics as required by Fort Detrick.

d. Storage and Application: Particular care must be taken in the storage and application of Aircraft Grade Compound to obtain satisfactory performance. Storage and application shall be in accordance with the instructions given in "Biological Safety Cabinets, Volume II, Purchase Description and Assembly Procedure: Assembly Procedure (March 1965), Sections V and VI."

3. Silicone-Type Sealant: This is a one-component silicone-type sealant as specified in "Biological Safety Cabinets, Volume II, Purchase Description and Assembly Procedure: Assembly Procedure (March 1965), Sections IV and VII." It can be substituted for Aircraft Grade Compound in applications requiring particularly good resistance to chemicals or high temperature. Special care must be taken to insure the use of recommended primers for this type of sealant.

B. Floor Coverings: See 1-05 C.

C. Protective Coatings

1. Contaminated Areas: In contaminated areas, protective coatings meeting the following requirements shall be applied to walls, ceilings, doors, exposed pipe, exposed insulation covering, and exposed metal, other than factory-finished items.

a. Priming and application shall be as recommended by the specific manufacturer. A heavy-consistency filler shall be used as a base coat for concrete block and cinder block surfaces.

b. Resistance to the following chemical and physical agents for 48 hours at room temperature is required:

4% hydrochloric acid.
4% sodium hydroxide.
1% quaternary ammonium compound.
5% formaldehyde.
25,000 ppm chlorine.
95% beta-propiolactone.
Scrubbing with stiff brush and hot water at 160 F after the paint surface has been saturated for 48 hours with any of the above chemical agents.

c. Tests have shown that some vinyl-base paints and some epoxy resin coatings resist the above chemical and physical agents.

d. In addition to meeting the above requirements, resistance to 2% peracetic acid is required for coatings used to protect surfaces within disinfectant shower enclosures (see 1-01 D.3).

2. Air Locks: Interior of ultraviolet air locks, and ultraviolet metal fixture shields, shall be painted with aluminum paint to provide high reflectivity.

3. Protective Coatings for Floors: Old concrete floors that are in good cleanable condition may be painted with 100% solids epoxy paint with anti-skid abrasive resistant aggregate added.

4. Paint Samples: See 1-08 E, Fort Detrick Design Practices.

1-07 REQUIRED LABORATORY EQUIPMENT

A. General: In the layout of contaminated laboratory rooms, attention shall be given to the following equipment, which is used in all laboratory buildings.

1. For detailed requirements of this equipment see Section 4, EQUIPMENT.

2. For electrical requirements of this equipment see 5-04, ELECTRICAL.

B. Class I Biological Safety Cabinet

1. Definition: See 4-01, EQUIPMENT.

2. Required Use: Every laboratory room in which test tubes of infectious agents are to be opened, or plates made from infectious material, or pipettings of infectious material made, or infected animals autopsied, or transfers made of infectious agents, or centrifuging of infectious materials performed shall be equipped with at least one biological safety cabinet, Class I installation. This requirement does not apply to rooms equipped with Class III cabinets. Class I cabinets should be located well away from doorways and room air supply openings to prevent drafts across the open front of cabinets.

C. Class III Biological Safety Cabinet

1. Definition: See 4-01, EQUIPMENT.

2. Required Use: Every infectious disease building shall have at least one laboratory equipped with biological safety cabinets, Class III (gastight), so that any agent without restriction may be used safely in at least one place in the building. The cabinet system should include adequate holding area and storage space to support experimental operations.

3. Design Requirements: See 4-01 E, EQUIPMENT.

4. Design Standards: See 4-01 F, EQUIPMENT, for reference to "Biological Safety Cabinets" catalog.

D. Laminar Airflow Safety Cabinets: The laminar airflow biological safety cabinet gives the same degree of operator protection as the Class I cabinet. In addition, the laminar airflow cabinet provides a sterile work environment that is useful for all microbiological procedures and is vital in tissue culture work. All laboratories where tissue culture work and infectious viruses are combined should consider obtaining a laminar airflow safety cabinet.

E. Sterilizers

1. Required Use: Every laboratory room or laboratory suite of rooms meeting the criteria of 1-07 B.2 above shall have a sterilizer, either a free-standing type or a double-door type with one end attached to a biological safety cabinet, so that no discarded infectious material will be removed from the room or safety cabinet system before being sterilized. The 20" x 20" x 36" size is desirable.

2. Design Requirements: See 4-06 B, EQUIPMENT.

F. Refrigerators and Incubators

1. Required Use: Each floor of a laboratory building (or building wing for large buildings) that meets the criteria of paragraph 1-07 B.2 above

shall have a walk-in refrigerator and walk-in incubator, so that there may be some isolation of agents when more than one agent is present in the building. Two small walk-in incubators and two small walk-in refrigerators conveniently located are preferable to one large walk-in incubator and one large walk-in refrigerator.

2. Design Requirements

a. For walk-in refrigerators and incubators see 1-03 H.

b. For other types see 4-03 and 4-05, EQUIPMENT.

G. Radiological Fume Hood

1. Required Use: At least one fume hood for handling radioactive isotopes shall be installed in each new building having chemical fume hoods installed therein. A radiological hood will be used in lieu of a chemical hood where only one hood is required for the building.

2. Design Requirements: See 4-09 F, EQUIPMENT.

1-08 FORT DETRICK DESIGN PRACTICES

A. Scope: This subsection contains criteria and design information not related to biological safety considerations and is not intended to be comprehensive.

B. Vinyl Tile Floors: Vinyl tile floor covering is used over applied cement finish in non-contaminated offices, lunch rooms, conference rooms, and corridors.

C. Acoustical Ceilings: Acoustical ceiling tile of noncombustible material is used in all non-contaminated offices and conference rooms unless otherwise specified.

D. Builders' Hardware

1. General: Unless otherwise specified, hardware shall conform to the requirements of Federal Specifications FF-H-106, FF-H-111, FF-H-116 and FF-H-121 and Army Guide Specifications CE-251.01 and CE-251.02.

2. Door Butts: Unless otherwise specified, selection of the type of butt hinges to be used shall be made in accordance with Department of the Army Guide Specifications CE-251.01, and CE-251.02. Butt hinges for use on exterior doors shall have pins that cannot be removed when the door is closed.

3. Door Closers: Unless otherwise specified, door closers shall be type 3001 and shall be provided with checking control. Closers for out-swinging, exposed-to-weather doors shall be either type 3009 reversible or type 3001 or 3009 with parallel arm. Size of closers shall be in accordance with Table I of Federal Specification FF-H-121c.

4. Door Stops: Floor stop type 1330 and 1330A shall be provided for all interior doors. Door holders type 1149A shall be provided for all interior doors having door closers. Floor stop type 1329E shall be provided for double-acting doors. Combination door stop and holder shall be provided for exterior doors.

5. Armor and Kick Plates

a. Kick plates shall be type 1225. The width shall be 1-3/4 inches less than the door width on the push side of the door, and 1/2 inch less than the door width on the pull side of the door. Kick plates shall be 10 inches high.

b. For armor plates see 1-05 A.6.

6. Hardware Finishes: Exposed surfaces of hardware shall have the following U.S. standard finishes:

a. US9: Unless otherwise specified, bronze hardware for exterior doors shall be furnished with US9 finish.

b. US10: Unless otherwise specified, bronze hardware for all interior doors shall be furnished with US10 finish.

c. US26: Brass or bronze hardware exposed in toilets, change rooms, and showers shall be furnished with US26 finish.

d. USP: Butts and door closers shall be furnished with USP finish.

7. Hardware Sets: Door hardware shall be limited to the following sets, the selection of which shall be made by the Government. Marked floor plan prints indicating the desired set for each door will be furnished the architect-engineer by the Government. Hardware sets listed but not indicated on the drawings shall be disregarded. Unless otherwise designated, numbers refer to Federal Specifications (see 1-08 D.1).

a. Single Swinging Single Doors (Interior):

H1
Butts
Hospital Arm Pull 458 (on both sides)
Roller Catch 193

H2
Butts
Hospital Arm Pull 458 (on one side)
Push Plate 465, 15 x 3½ inches (on one side)
Kick Plate or Armor Plate, on one side (see 1-08 D.5 above).
Door Closer 3001

H2A (Corridor entrance door to clean change rooms)
Butts
Hospital Arm Pull 458 (on one side)
Push Plate 465, 15 x 3½ inches (on one side)
Kick Plate, on one side
Door Closer 3001

H3
Butts
Hospital Arm Pull 458 (on both sides)
Roller Catch 193
Cylinder Mortise Deadlock, Sargent #222

H4
Butts
Hospital Arm Pull 458 (on one side)
Push Plate 465, 15 x 3½ inches (on one side)
Cylinder Mortise Deadlock, Sargent #222
Kick Plate or Armor Plate, on one side (see 1-08 D.5 above).
Door Closer 3001

H5
Butts
Mortise Knob Latch 185
Lever Handles and Roses 223

H6
Butts
Mortise Knob Latch 185
Lever Handles and Roses 223
Door Closer 3001

H7
Butts
Mortise Knob Latch 185
Lever Handles and Roses 223
Cylinder Mortise Deadlock, Sargent #222

H8
Butts
Mortise Knob Latch 185
Lever Handles and Roses 223
Cylinder Mortise Deadlock, Sargent #222
Door Closer 3001

H8A
Butts
Cylinder Mortise Lock, Best Universal
#2600-M06E02, Less door knobs and roses, with cylinder
#1E64 less core
Lever Handles and Roses 223
Door Closer 3001

H8B
Butts
Mortise Knob Latch 185
Lever Handles and Roses 223
Mortise Deadlock, Best Universal
4T6D9 (see 1-05 1.7b).

b. Single Swinging Double Doors (Interior):

H9
Butts
Hospital Arm Pull 458 (on pull side of each door)
Push Plate 465, 15 x 3½ inches (on push side of each door)
Kick Plate or Armor Plate, see 1-08 D.5 above (on push side of each door)
Door Closer 3001 (on one side of each door)

H10
Butts
Hospital Arm Pull 458 (on pull side of active leaf)
Push Plate 465, 15 x 3½ inches (on push side of each door)
Kick Plate or Armor Plate, see Paragraph 1-08 D.5 above (on push side of each door)
Door Closer 3001 (on one side of each door)
Cylinder Mortise Deadlock, Sargent #222 (on active leaf)
Lever Extension Flush Bolts 1045 and 1048 (on inactive leaf)

H11
Butts
Mortise Knob Latch 185 (on active leaf)
Lever Handles and Roses 223 (on active leaf)
Lever Extension Flush Bolts 1045 and 1048 (on inactive leaf)

H12
Butts
Mortise Knob Latch 185 (on active leaf)
Lever Handles and Roses 223 (on active leaf)
Lever Extension Flush Bolts 1045 and 1048 (on inactive leaf)
Door Closer 3001 (on active leaf)

H13
Butts
Mortise Knob Latch 185 (on active leaf)
Lever Handles and Roses 223 (on active leaf)
Lever Extension Flush Bolts 1045 and 1048 (on inactive leaf)
Door Closer 3001 (on active leaf)
Cylinder Mortise Deadlock, Sargent #222 (on active leaf)

H14
Butts
Cylinder Mortise Lock, Best Universal #2600-M06E02 with cylinder 1E64 less core (on active leaf)

2.66

Lever Extension Flush Bolts 1045 and 1048 (on inactive leaf)

HI4A
Butts
Mortise Knob Latch 185 (on active leaf)
Lever Handles and Roses 223 (on active leaf)
Mortise Deadlock, Best Universal 4T0D9 (on active leaf)
Lever Extension Flush Bolts 1045 and 1048 (on inactive leaf)

c. Double-Acting Single Door (Interior):

HI5
Spring Butt Hinges, Sargent (Bommer)
Push Plate 465, 15 x 3½ inches (on both sides)
Kick Plate or Armor Plate see 1-08 D.5 above (on both sides)
Cylinder Mortise Deadlock, Sargent #222

HI6
Spring Butt Hinges, Sargent (Bommer)
Push Plate 465, 15 x 3½ inches (on both sides)
Kick Plate or Armor Plate, see 1-08 D.5 above (on both sides)

d. Double-Acting Double Door (Interior):

HI7
Spring Butt Hinges, Sargent (Bommer)
Push Plate 465, 15 x 3½ inches (both sides of each leaf)
Kick Plate or Armor Plate, see 1-08 D.5 above (both sides of each leaf)

HI7A
Spring Butt Hinges
Push Plate 460 (on both sides of each leaf)
Kick Plate see Paragraph 2-09 d. above (on both sides of each leaf)
Mortise Deadlock, Best 4T0D9 (on active leaf)
Lever Extension Flush Bolts 1045 and 1048 (on inactive leaf)

e. Sliding Door (Interior):

HI8
Sliding Door Lock, 197
Track and Bangers, Grant #12, or approved equal.

f. Walk-In Refrigerator and Incubator Rooms:

HI9
Similar to Type "A" Jamison Cold Storage Doors, except that hardware shall be furnished with US26 finish and shall be equipped with padlocking handle and an automatic release from the inside to enable release from inside

whether the outside handle is padlocked or free.

g. Emergency Exit (Crash) Doors:

H20
Butts
Panic Bolt 821

h. All Exterior Doors (unless otherwise specified):

H21
Butts
Cylinder Mortise Lock, Best Universal #2600-M06E02 with cylinder 1E64 less core.
Door Closer

H22
Butts
Cylinder Mortise Lock, Best Universal #2600-M06E02 with cylinder 1E64 less core (on active leaf)
Door Closer (on active leaf)
Lever Extension Flush Bolts 1045 and 1048 (on active leaf)

H23
Butts
Cylinder Mortise Lock, Best Universal #2600-M06E02 with cylinder 1E64 less core (on active leaf)
Lever Extension Flush Bolts 1045 and 1048 (on inactive leaf)

i. Doors to Disinfectant Showers:

H24
Butts, Refrigerator Door Type Hinge, corrosion-resistant steel.
Fastener, 3 point interconnected Smokehouse type "Jamison" or equal with inside operating lever and "O" ring seal on fastener thru-rod, corrosion-resistant steel and US26 finish. All hardware shall be factory applied.

E. Protective Coatings

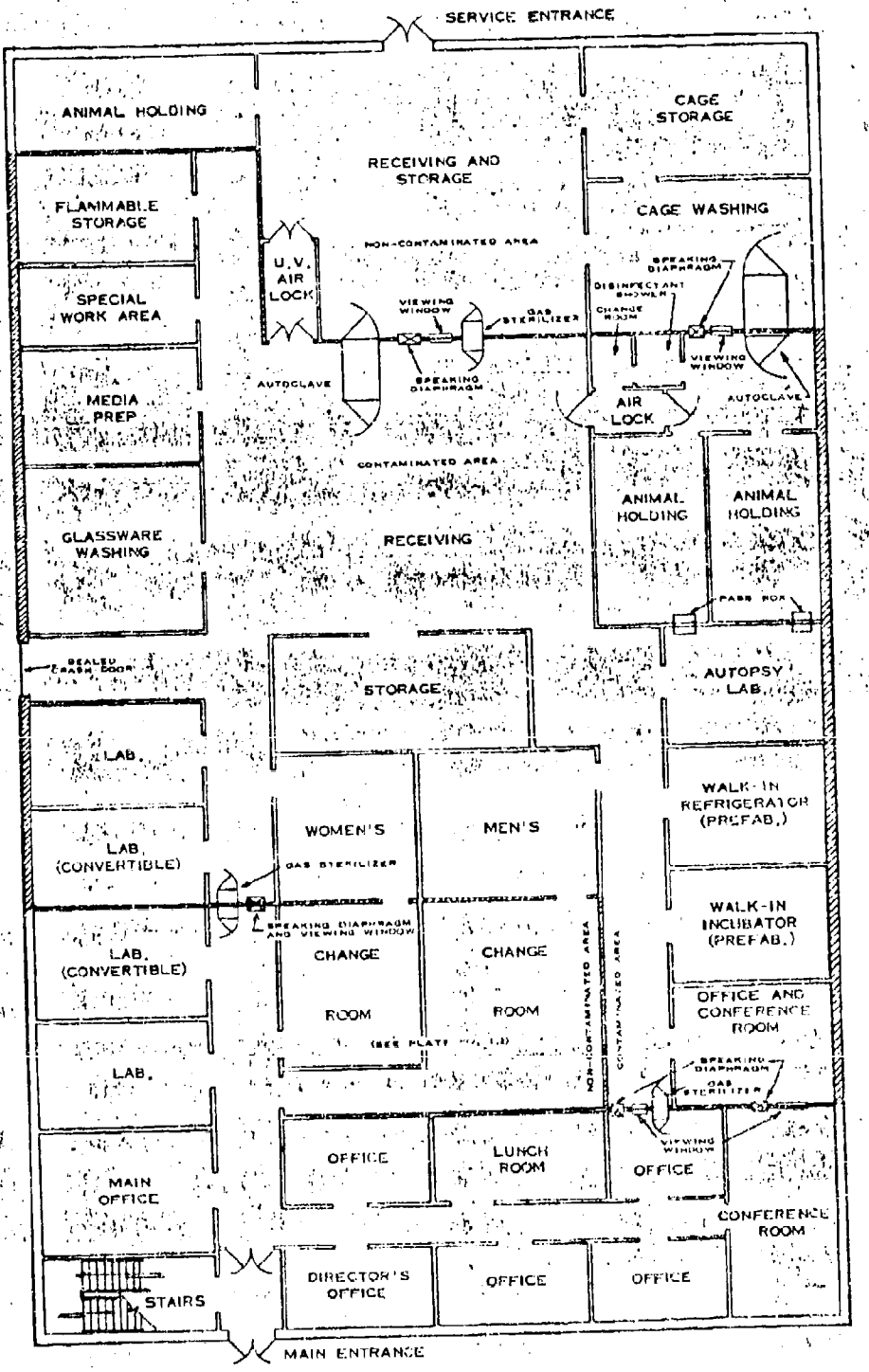
1. Contaminated Areas: See 1-06 C.

2. Non-Contaminated Areas: Non-contaminated areas shall be painted with semi-gloss enamel paint conforming to Federal Specifications TT-E-508, except that:

a. Gloss enamel paint conforming to Federal Specification TT-E-506 shall be used for painting toilet rooms.

3. Samples: Sample of protective coating, in sealed container with printed instructions for application, shall be submitted to the Contracting Officer for approval.

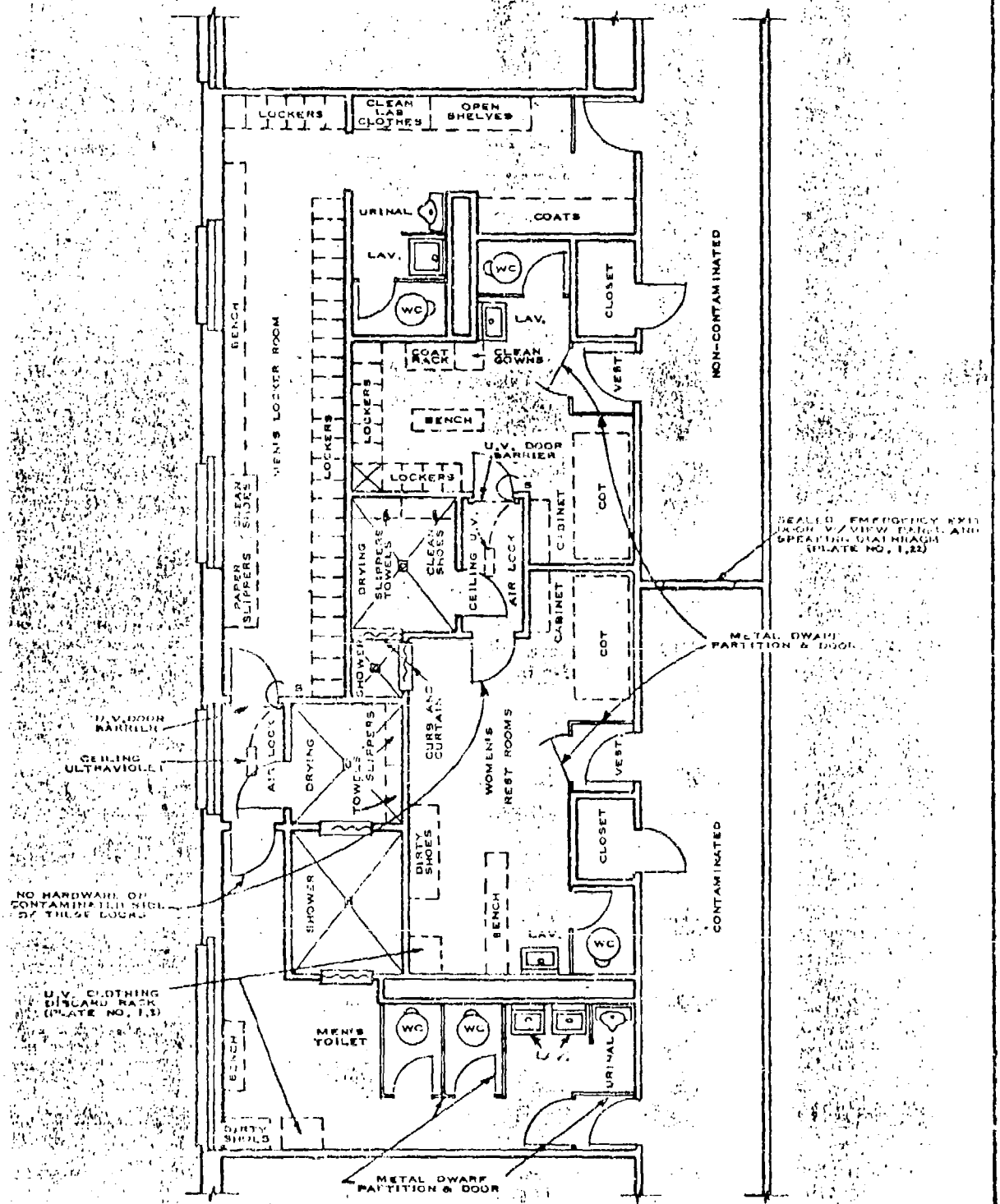
4. Piping Color Code: See 3-07, PIPING.



NOTE

THIS DIAGRAM IS INTENDED ONLY TO ILLUSTRATE THE VARIOUS ROOM RELATIONSHIPS IMPOSED BY THE CRITERIA LISTED IN 1.01, 1.02 AND 1.03. IT SHOULD NOT BE TAKEN AS A PRACTICAL LAYOUT.

ILLUSTRATIVE BUILDING LAYOUT	REV.	DATE	DESCRIPTION
		DATE - 1 FEB. 66	PLATE NO. 1.1

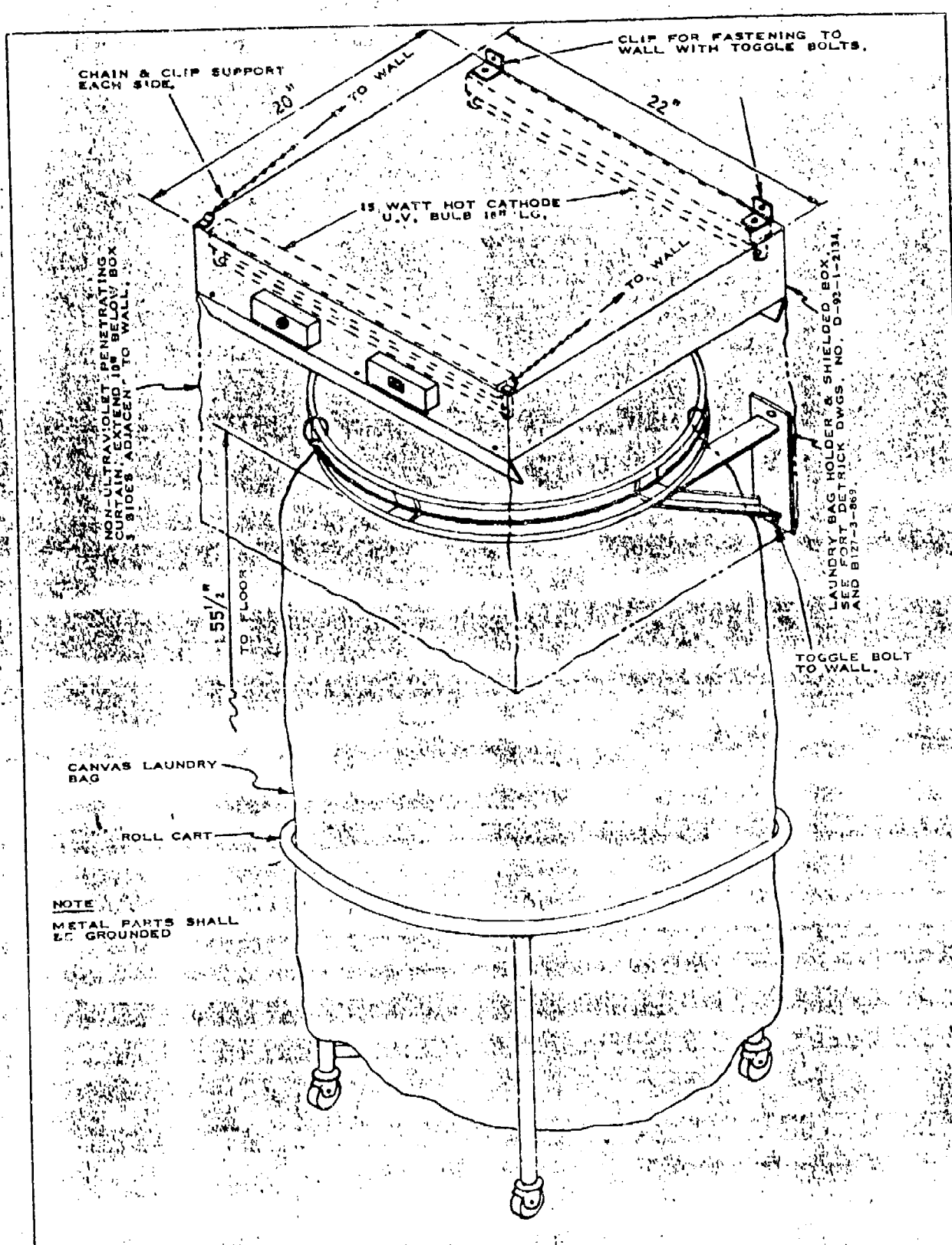


CHANGE ROOMS FOR MEN AND WOMEN
(ILLUSTRATING NECESSARY ELEMENTS)

REV.	DATE	DESCRIPTION

DATE - 1 FEB. 66

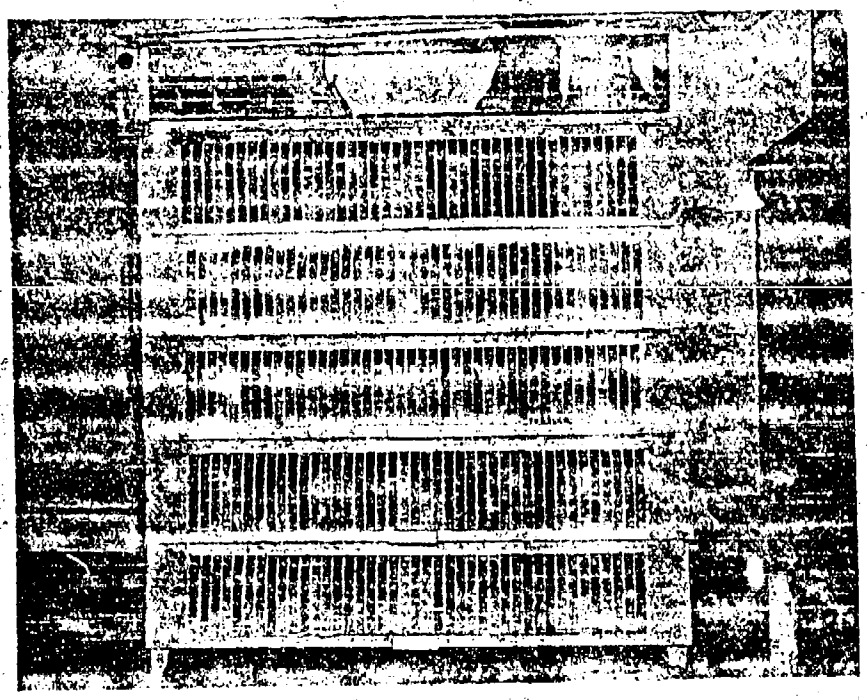
PLATE NO. 1.2



ULTRAVIOLET CLOTHING DISCARD RACK	REV.	DATE	DESCRIPTION
		DATE - 1 FEB. 66	PLATE NO. 1.3

U.V. Clothing Discard Rack

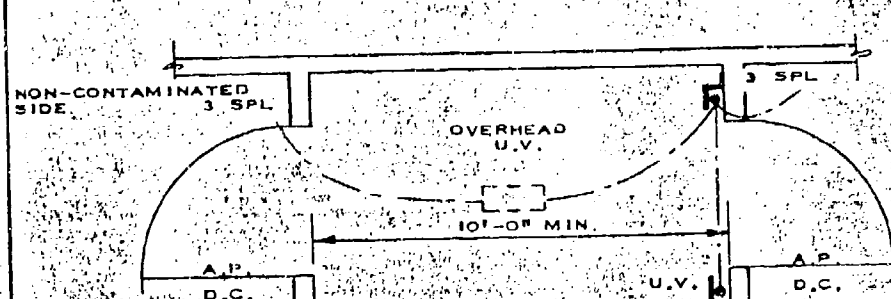
PLATE NO. 1.4



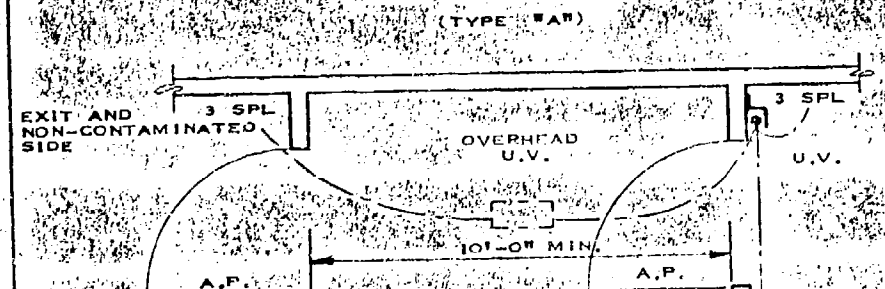
U.V. Shoe Rack

PLATE NO. 1.5

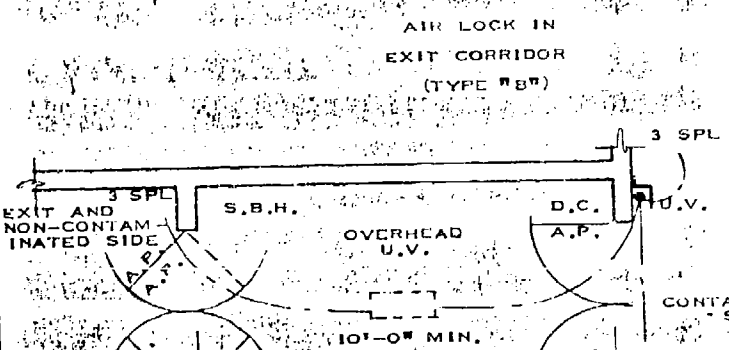
2/66



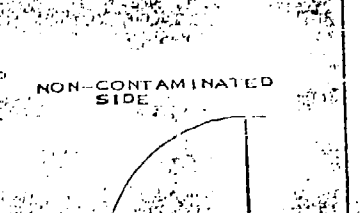
TYPICAL AIR LOCK
EXCEPT IN EXIT CORRIDOR
(TYPE "A")



AIR LOCK IN
EXIT CORRIDOR
(TYPE "B")



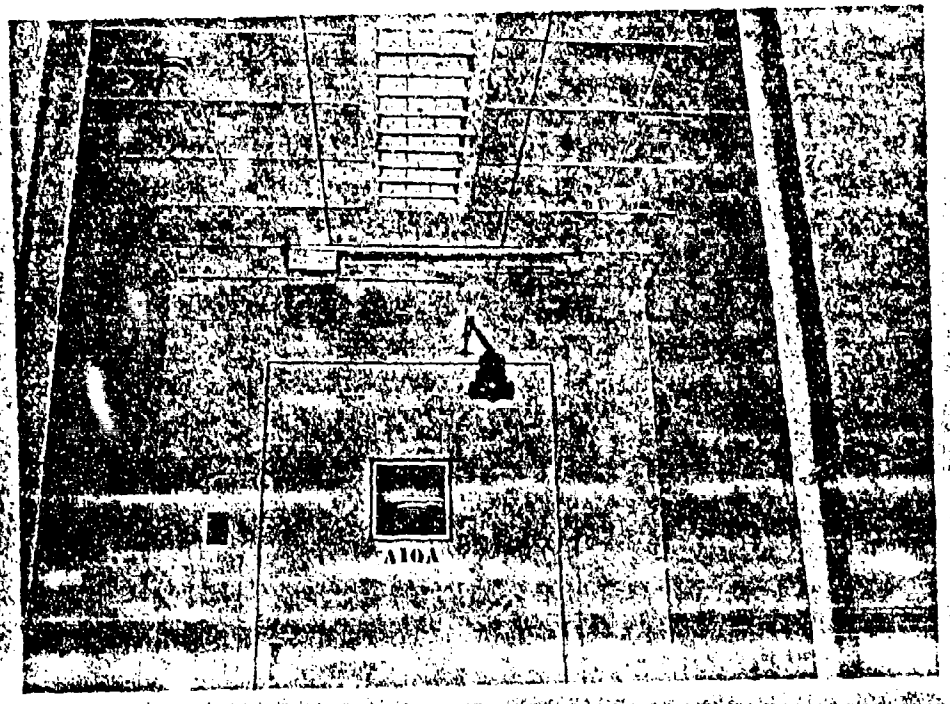
AIR LOCK WITH DOUBLE
DOORS WHEN REQUIRED
(TYPE "C")



U.V. BARRIER AT
SINGLE DOOR
TYPE "D"

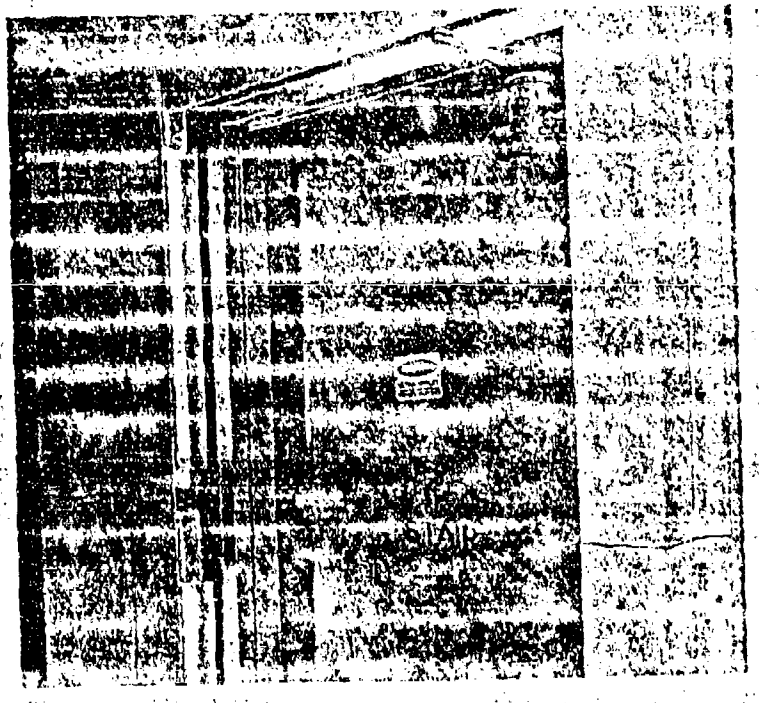
D.C. -DOOR CLOSER
A.P. -ARMOR PLATE (ON SIDE SHOWN)
S. -SWITCH
S.B.H. -SPRING BUTT HINGES
U.V. -ULTRAVIOLET
3 SPL -THREE-WAY SWITCH

U. V. AIR LOCKS AND DOOR BARRIERS	REV.	DATE	DESCRIPTION
		DATE - 1 FEB. 66	PLATE NO. 1.6



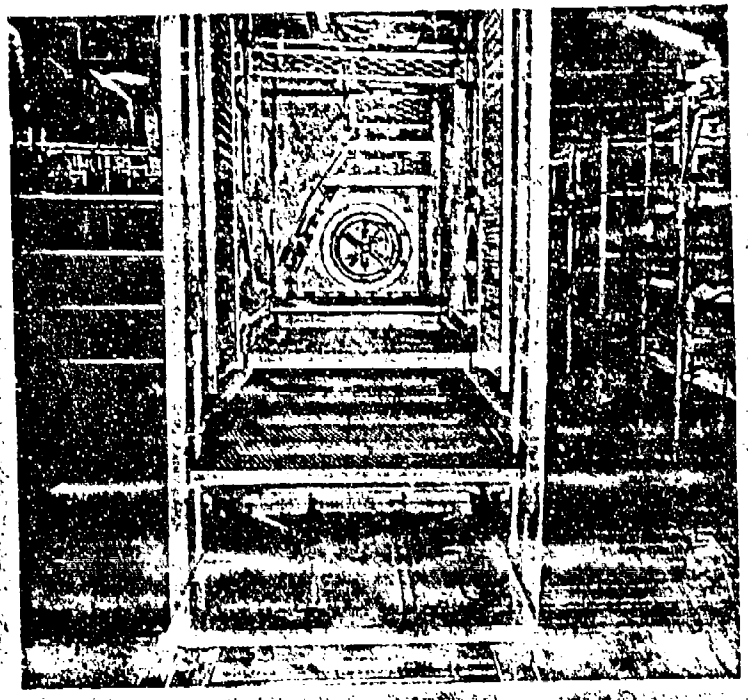
Air Lock with Ceiling U.V.

PLATE NO. 1.7



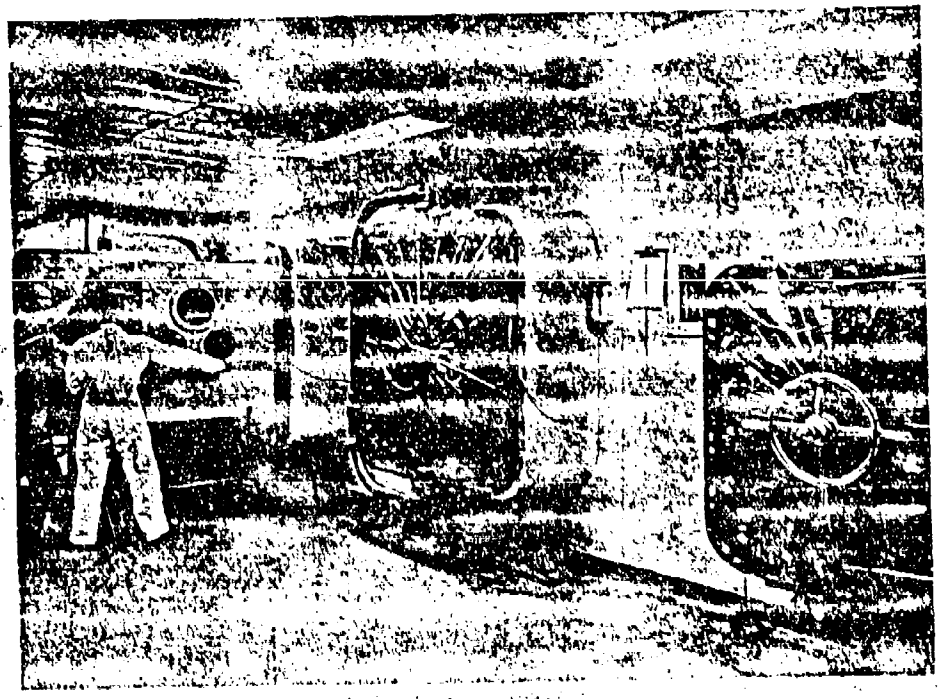
U.V. Door Barrier

PLATE NO. 1.8



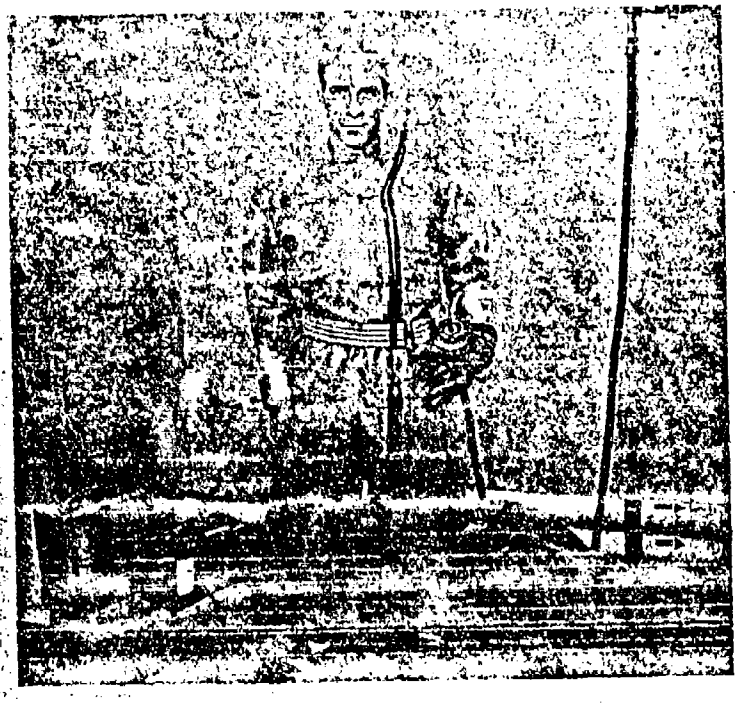
Transport Chamber for Autoclaving of Animal Cages. Cage Racks in Background

PLATE NO. 1.9



Loading Transport Chamber Filled with Contaminated Animal Cages into Autoclave for Transfer to Cage Washing Room

PLATE NO. 1.10

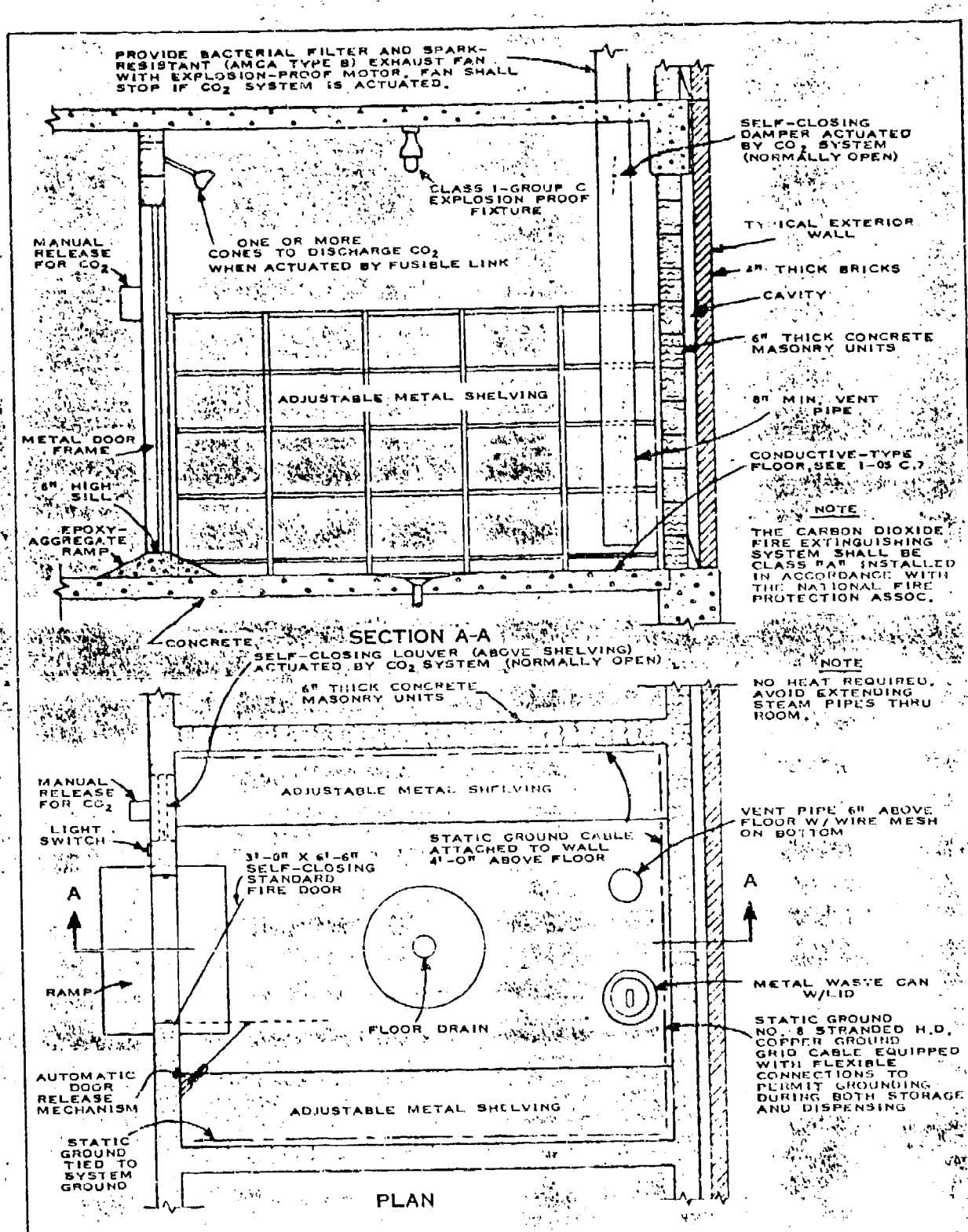


Man in Ventilated Suit

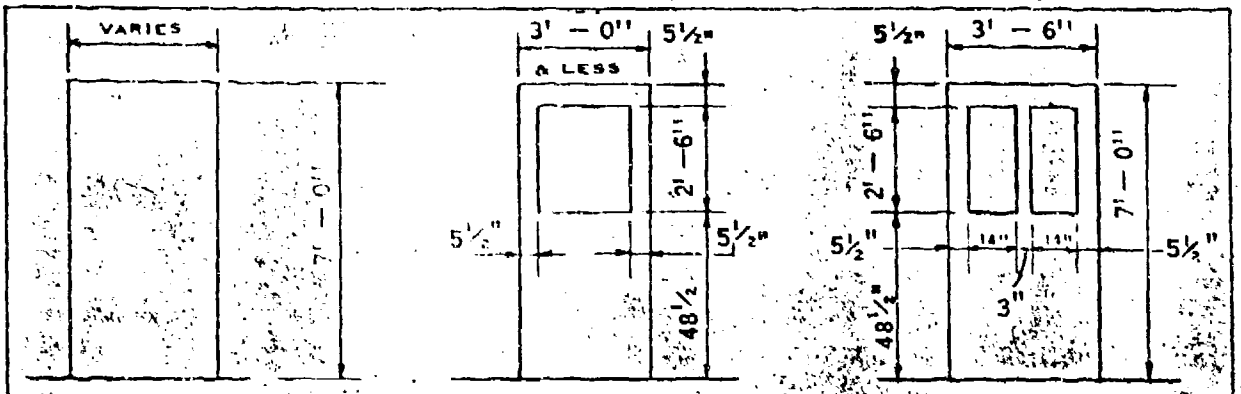
PLATE NO. 1.11

Man in Ventilated Hood

PLATE NO. 1.12



TYPICAL FLAMMABLE MATERIAL STORAGE ROOM 8' - 0" X 10' - 0" MIN. ROOM SIZE	REV.	DATE	DESCRIPTION
		DATE - 1 FEB. 66	PLATE NO. 1.13



ALL DOORS

UNLESS SPECIFIED OTHERWISE
(SPECIFY WIDTH)

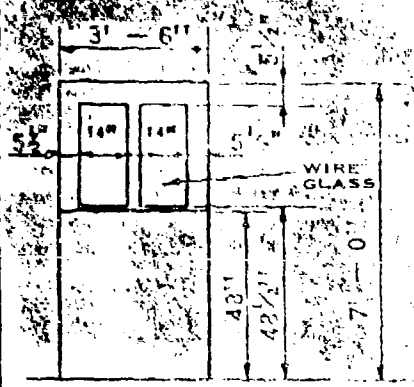
TYPE "A"

GLAZED DOOR

(SPECIFY WIDTH)
TYPE "B" (CLEAR GLASS)
TYPE "B-1" (OBSCURE GLASS)
TYPE "B-2" (WIRE GLASS)

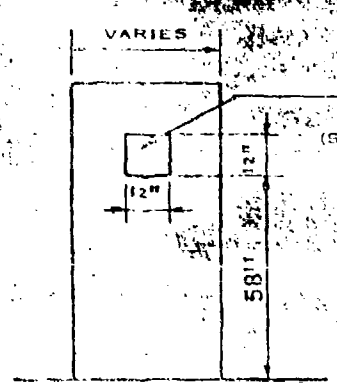
GLAZED DOOR

3'-6" WIDE
TYPE "C" (CLEAR GLASS)
TYPE "C-1" (OBSCURE)

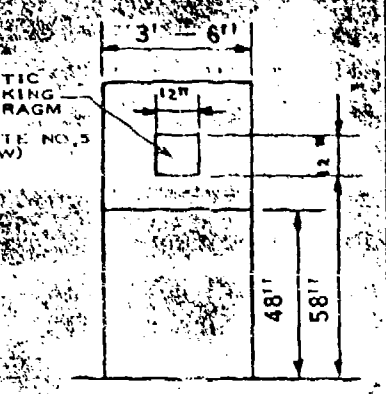


GLAZED DOORS
WITH 4'-0" HIGH
ARMOR PLATE

TYPE "D"



DOOR WITH
SPEAKING
DIAPHRAGM
(SPECIFY WIDTH)
TYPE "E"



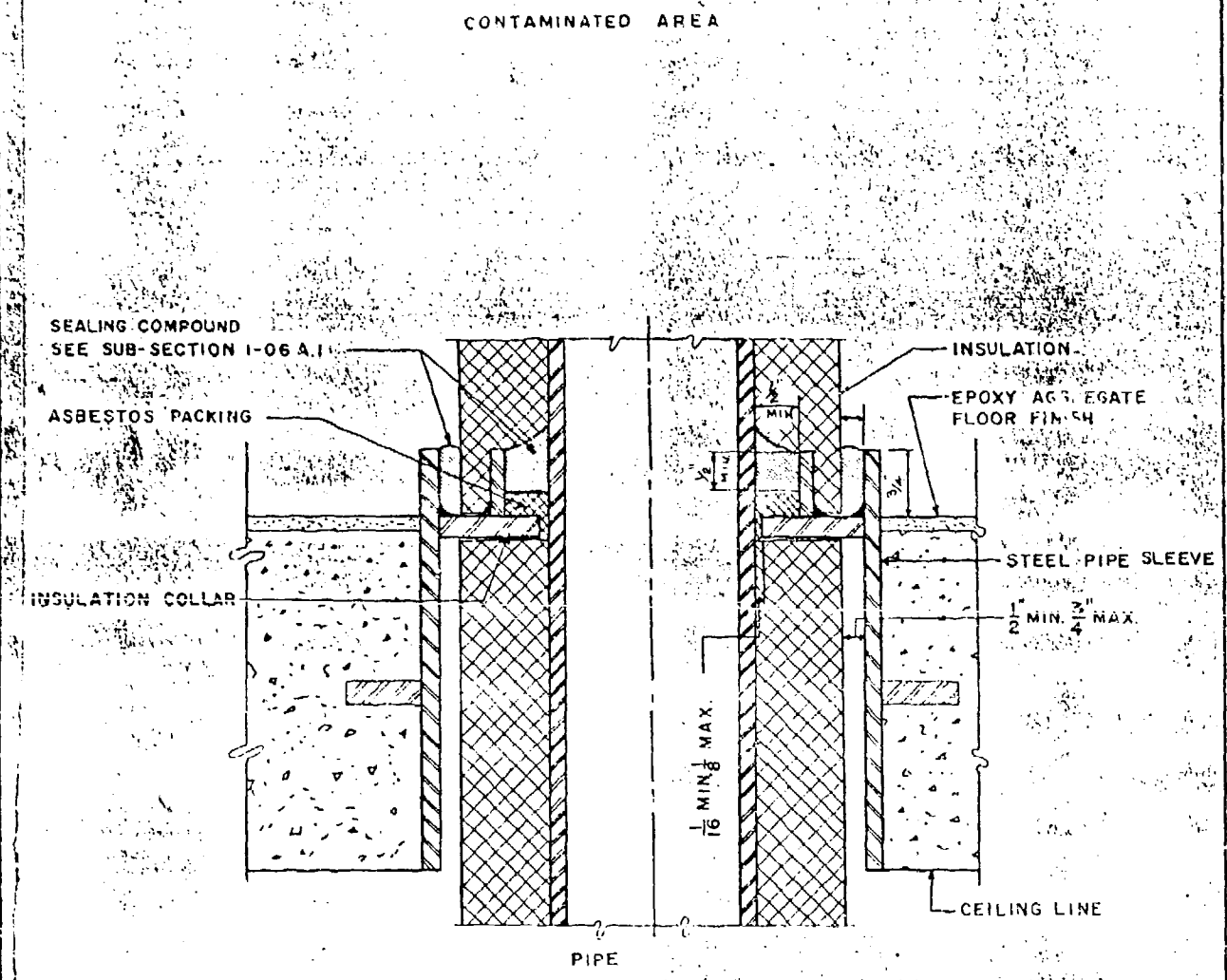
DOOR WITH SPEAKING
DIAPHRAGM & 4'-0"
HIGH ARMOR PLATE

TYPE "F"

NOTES

1. CLEAR GLASS - FOR ALL GLAZED DOORS, UNLESS OTHERWISE SPECIFIED.
2. OBSCURE GLASS - FOR GLAZED DOORS TO REST ROOMS, TOILET ROOMS, LOCKER ROOMS, STORE ROOMS, AND DIVISION CHIEF'S OFFICE.
3. CLEAR WIRE GLASS - FOR ALL GLAZED DOORS HAVING 4' 0" HIGH ARMOR PLATE (EXCEPT DOORS WITH SPEAKING DIAPHRAGM WITHOUT GLASS). ALSO FOR ALL GLAZED DOUBLE-ACTING DOORS, KALAMEIN DOORS, ELEVATOR DOORS, CORRIDOR DOORS THAT MAY FUNCTION AS FIRE BARRIERS AND FOR OUTSIDE ENTRANCE DOORS TO BASEMENT.
4. ARMOR PLATES, 4'-0" HIGH - SEE PARAGRAPH 1-05 A.6.
5. A 6" DIA. PLASTIC SPEAKING DIAPHRAGM - 58" ABOVE FLOOR MAYBE USED IN CONNECTION WITH GLAZED DOORS BY INSTALLING SAME IN THE GLASS PANEL. SEE PLATE NO. 1.22.
6. WALK-IN INCUBATOR DOORS AND WALK-IN REFRIGERATOR DOORS - TO BE EQUIPPED WITH A 12" X 12" THERMOPANE (OR EQUAL) VIEW GLASS PLACED 58" FROM FLOOR TO BOTTOM.

INTERIOR DOORS	REV. / DATE	DESCRIPTION
	DATE - 1 FEB. 66	PLATE NO. 1.14

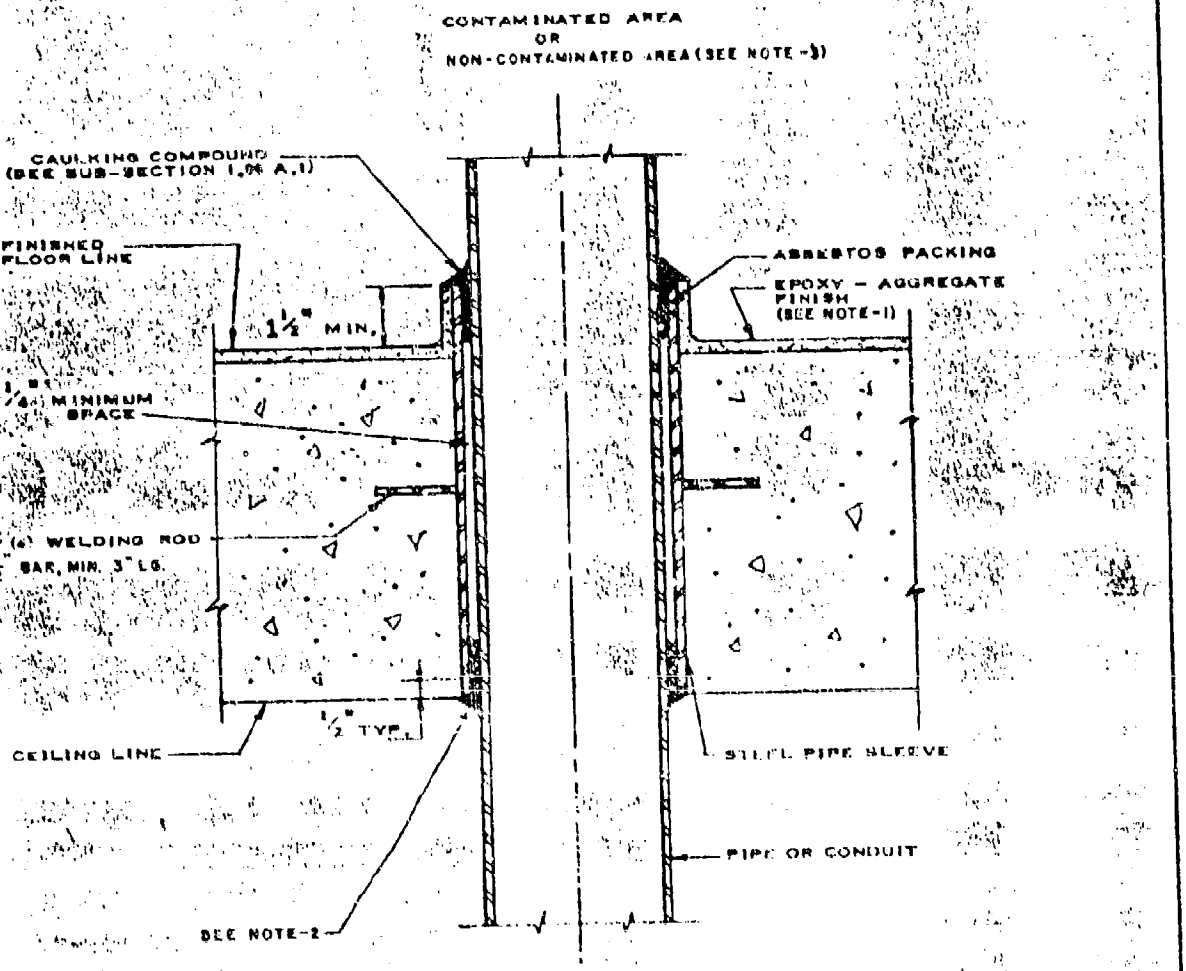


NOTES

1. IF BOTH SIDES OF THE FLOOR ARE CONTAMINATED BOTH ENDS OF THE SLEEVE MUST BE SEALED. INSULATION SHALL BE OMITTED FROM THE CENTER VOID BETWEEN INSULATION COLLARS

Sealing Compound

TYPICAL METHOD OF SEALING AROUND INSULATED LINES EXTENDING THROUGH FLOORS	REV.	DATE	DESCRIPTION
	DATE – 1 NOV, 69		PLATE NO. 1.15

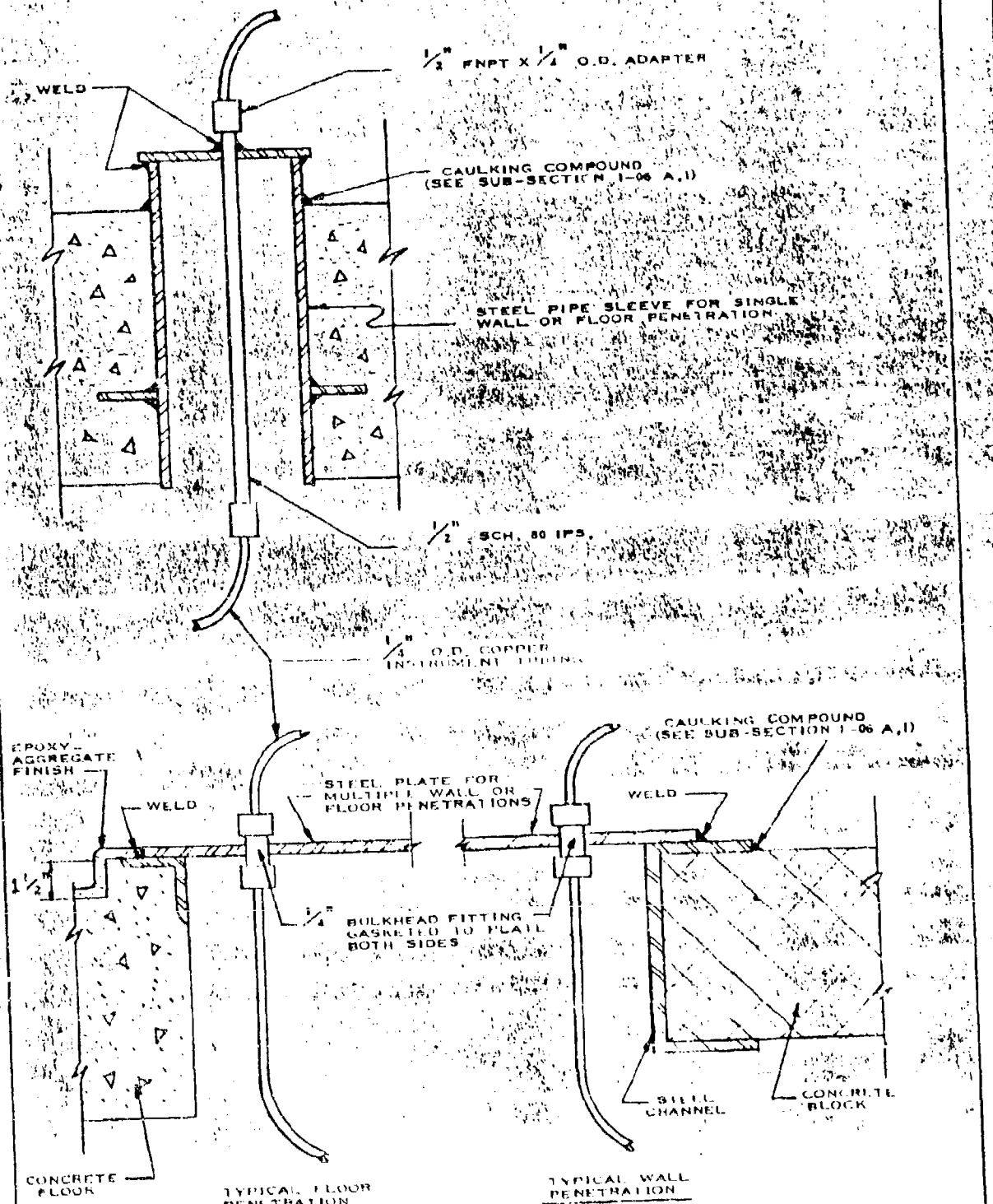


NOTE-1 NON-CONTAMINATED AREA FLOOR FINISH (PER SUB-SECTION 1-04 J,2C)

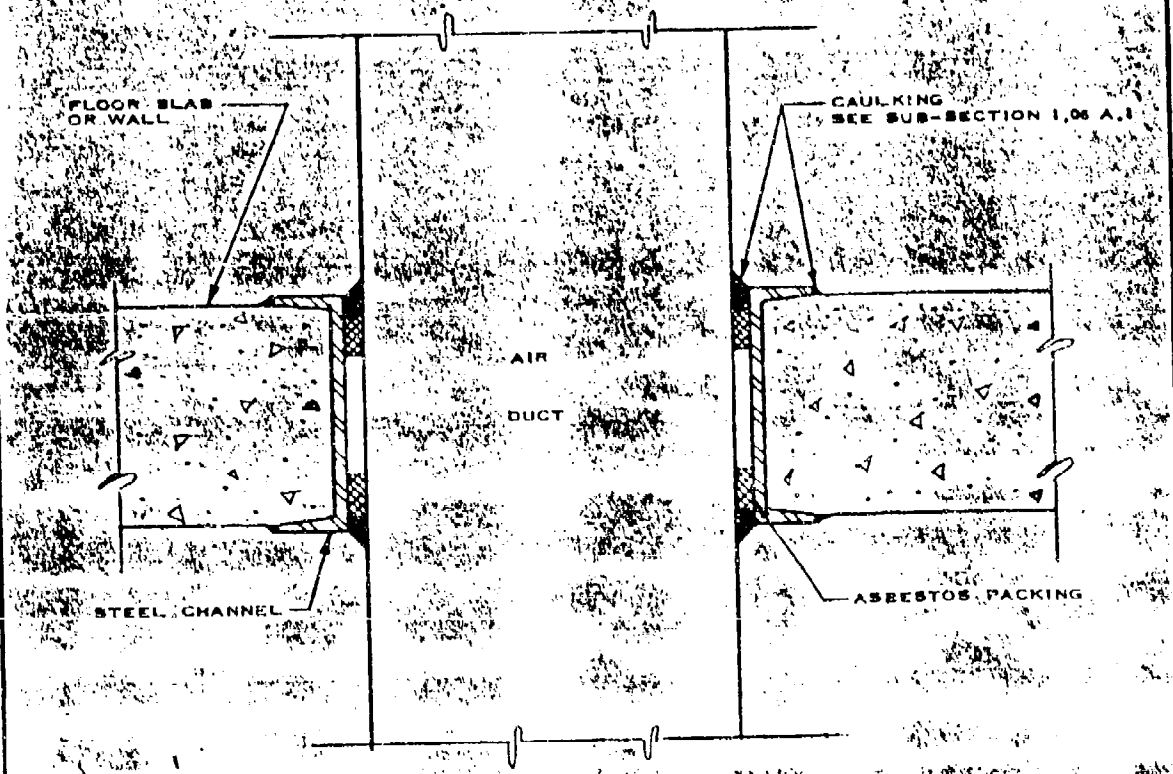
NOTE-2 NON-CONTAMINATED AREA, PACKING AND CAULKING OPTIONAL

NOTE-3 NON CONTAMINATED AREA BOTH SIDES, PIPE SLEEVE OPTIONAL

TYPICAL METHOD OF SEALING AROUND NON-INSULATED LINES EXTENDING THROUGH FLOORS	1	23AUG 67	ADDED NOTES 1,2,&3
	REV.	DATE	DESCRIPTION
	DATE 1 FEB. 66		PLATE NO. 1.16

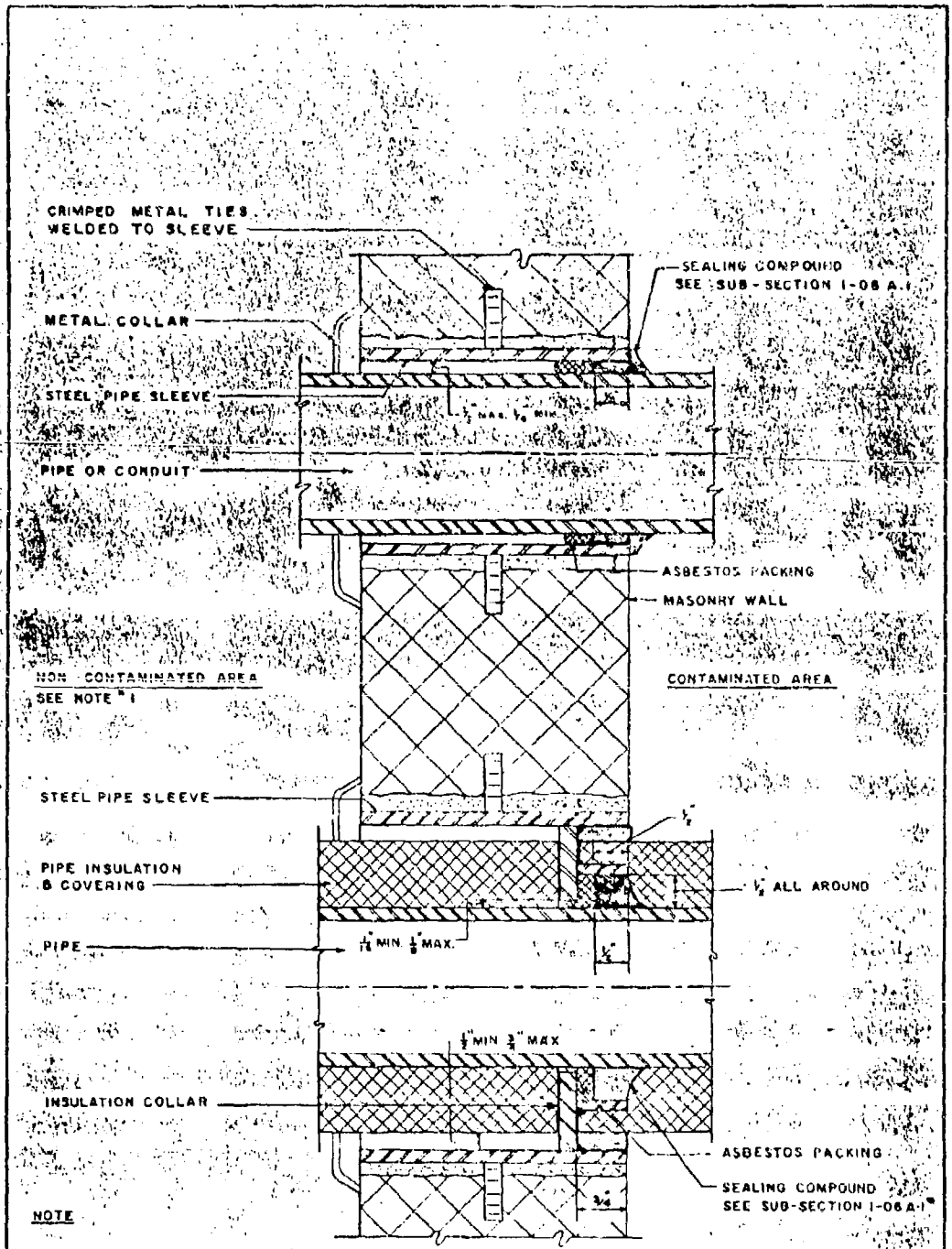


SEAL AROUND INSTRUMENT TUBING THROUGH FLOOR OR WALLS	REV.	DATE	DESCRIPTION
		DATE - 1 FEB. 66	PLATE NO. 1.17



TYPICAL METHOD OF SEALING AROUND AIR DUCT EXTENDING THROUGH FLOOR OR INTERIOR WALL

REV.	DATE	DESCRIPTION
DATE - 1 FEB. 66		PLATE NO. 1.18



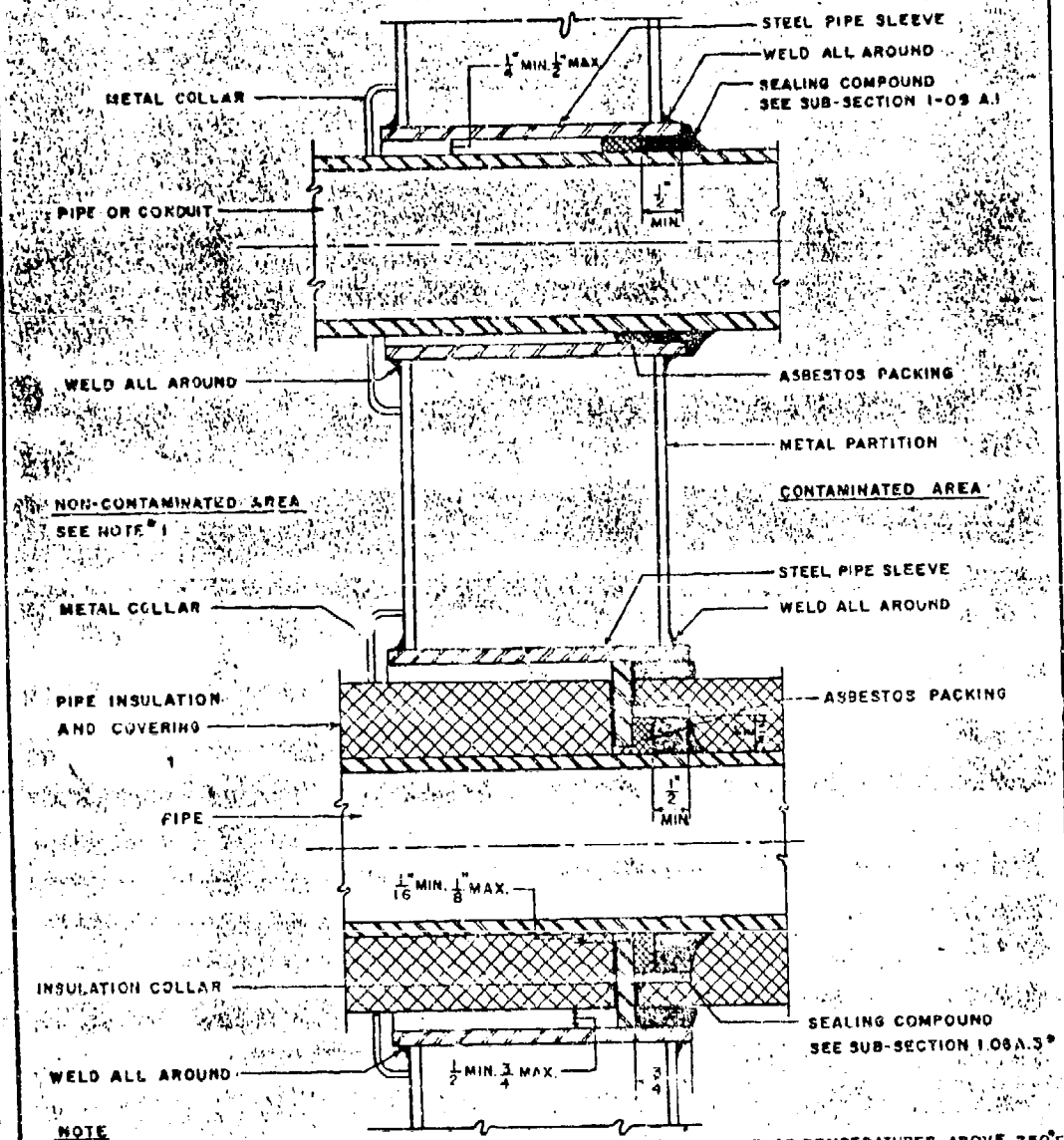
NOTE

1. IF BOTH SIDES OF THE WALL ARE CONTAMINATED BOTH ENDS OF THE SLEEVE SHALL BE SEALED. INSULATION SHALL BE OMITTED FROM THE CENTER VOID BETWEEN THE INSULATION COLLARS

* FOR SURFACE TEMPERATURES ABOVE 250° F USE SILICONE TYPE SEALANT, SEE 1-08A-3

Sealing Compound

METHOD OF SEALING INSULATED AND NON-INSULATED LINES EXTENDING THROUGH MASONRY WALLS	REV	DATE	DESCRIPTION
	DATE – 1 NOV 69		PLATE NO. 1.19



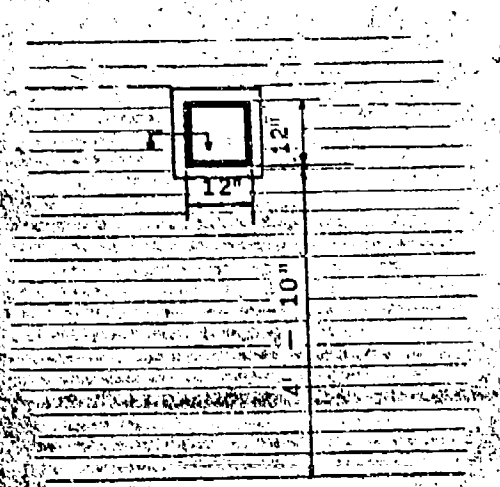
NOTE

1. IF BOTH SIDES OF THE PARTITION ARE CONTAMINATED, BOTH ENDS OF THE SLEEVE MUST BE SEALED. INSULATION SHALL BE OMITTED FROM THE CENTER VOID BETWEEN INSULATION COLLARS

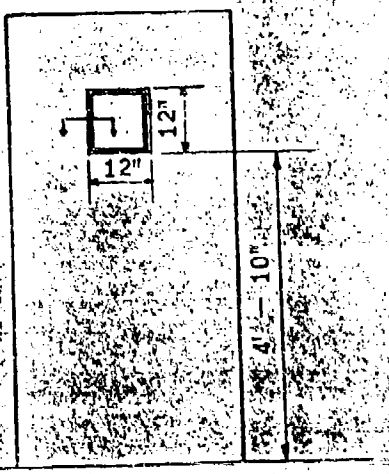
* FOR SURFACE TEMPERATURES ABOVE 250°F USE SILICONE TYPE SEALANT. SEE 1-08 A.3

Sealing Compound

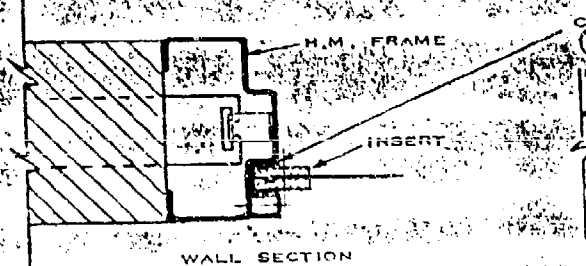
METHOD OF SEALING INSULATED AND NON-INSULATED LINES EXTENDING THROUGH METAL PARTITIONS	REV	DATE	DESCRIPTION
		DATE-1 NOV. 69	PLATE NO. 1.20



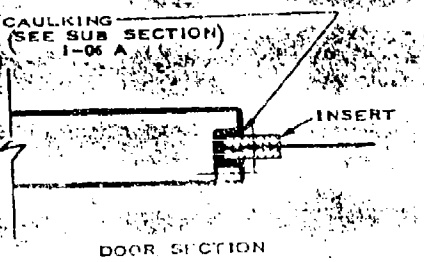
WALL MOUNTED
SCALE 3/8" = 1'-0"



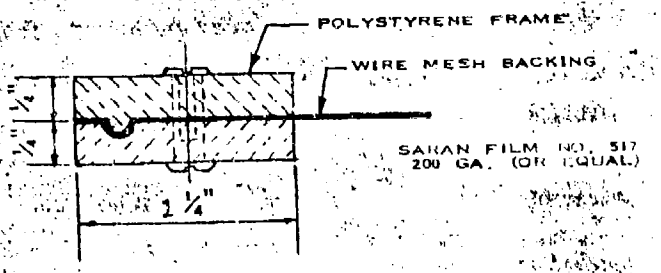
DOOR MOUNTED
SCALE 3/8" = 1'-0"



WALL SECTION
SCALE 3" = 1'-0"



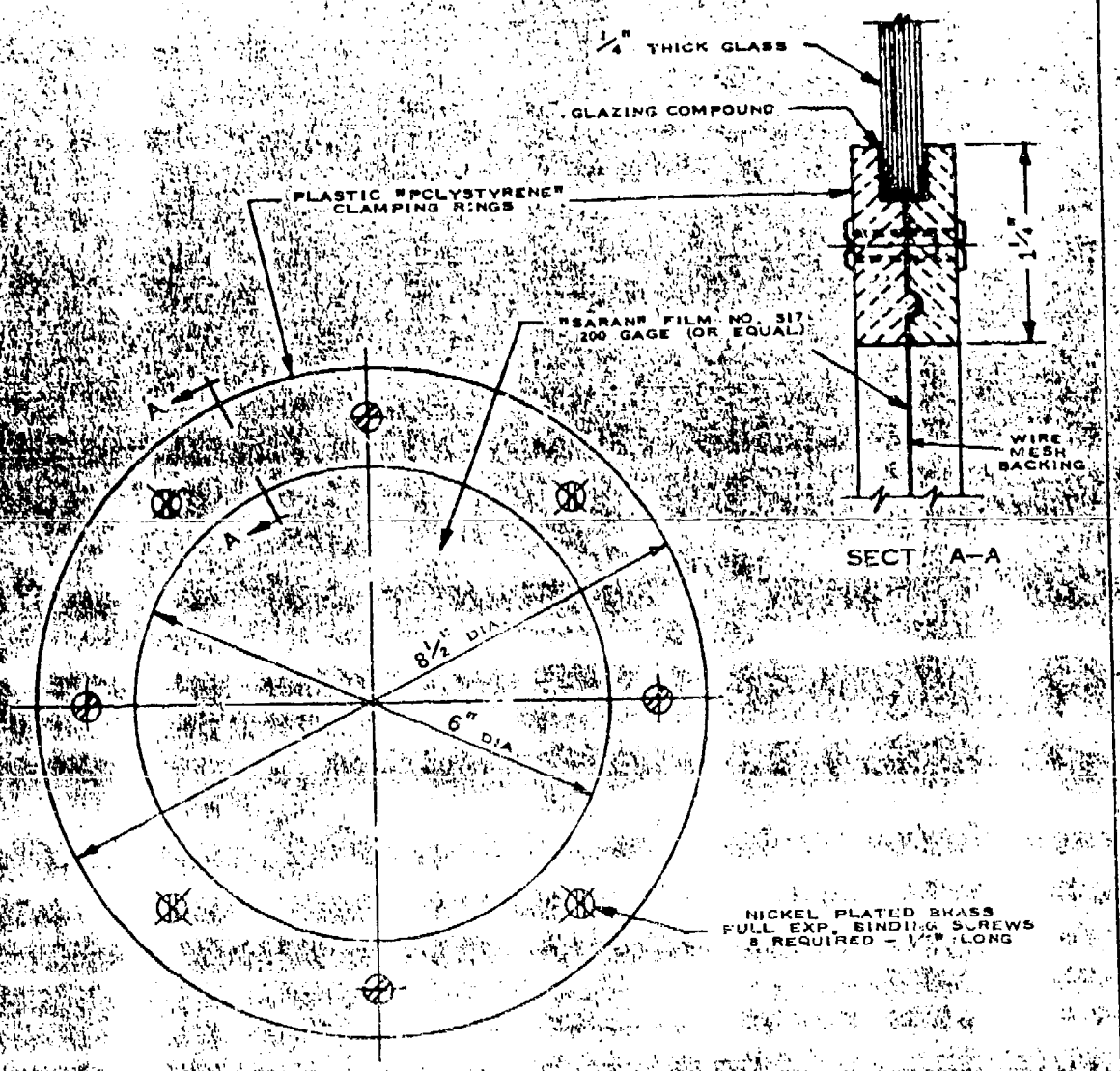
DOOR SECTION
SCALE 3" = 1'-0"



INSERT SECTION
FULL SCALE

SPEAKING DIAPHRAGM FOR SEPARATE INSTALLATION

REV.	DATE	DESCRIPTION
	DATE - 1 FEB, 66	PLATE NO. 1.21



SPEAKING DIAPHRAGM INSTALLED IN GLAZED VIEW PANEL	REV.	DATE	DESCRIPTION
	DATE - 1 FEB. 66		PLATE NO. 1.22

2/66

1.25H

SECTION 2 - HEATING, VENTILATION AND AIR CONDITIONING

TABLE OF CONTENTS

LIST OF PLATES

SECTION 2

HEATING, VENTILATION AND AIR CONDITIONING

2-00 INTRODUCTION

A. Scope

This section is addressed primarily to those architect-engineering personnel concerned specifically with heating, ventilation and air conditioning in the engineering and design of microbiological facilities at Fort Detrick. It applies to new facilities, and to modifications and additions to existing facilities.

We repeat here again, as in every section, that the purpose of this manual is to present special design criteria based primarily on biological safety considerations. It is not intended to duplicate the fund of standards and criteria normally possessed by the architect-engineer. However, a sub-section of Fort Detrick design practices not related to safety considerations is given at the end of this section. In addition, Appendix A lists a number of Fort Detrick Purchase Descriptions and Specifications which may be obtained from the Contracting Officer.

As described in Volume I, Fort Detrick contains a variety of facilities, such as laboratories, pilot plants, test chambers, filling lines, storage areas and others. This manual presents the criteria that all of these facilities have in common. To avoid vagueness, many of the criteria are stated in terms of laboratory buildings, but this should not to be taken to mean that they are not generally applicable.

With some exceptions, the requirements peculiar to each type of facility are not covered in this manual.

B. Conversions and Modifications

The application of the criteria presented here to the design of new facilities generally will be straightforward. However, many projects involve the conversion or modification of existing facilities. Since these facilities were built there have been changes in the criteria, based on technical innovations or operating experience. As a result, it is important for the designer of such modifications to exercise judgment and flexibility in applying the new criteria. Some of the potential problems will be resolved by the specific Contract Scope of Work for the individual project, or by other guidance provided by the Government.

C. Organization of Section 2

The remainder of this section is divided into the following main sub-sections:

1. Basic approach
2. Air flow patterns
3. Design conditions
4. Supply and exhaust systems, general
5. Special rooms
6. Ventilation of safety cabinets
7. Ventilation of other special equipment
8. Contaminated vent systems to incinerator
9. Bacterial filters
10. Methods and materials
11. Controls
12. Testing and balancing
13. Fort Detrick design practices

2-01 BASIC APPROACH

A. General

Biological safety recognizes varying degrees of potential hazard in laboratory buildings based upon the anticipated or experienced concentration of microorganisms in air. Microorganisms are either intentionally or accidentally released into the air by various laboratory operations.

Microorganisms suspended in air tend to travel with air movement. Air handling systems that control the direction of air flow are effective in controlling the movement of the suspended microorganisms. The engineer-designer, particularly the designer of the air handling systems, must be aware of and remain cognizant of the existence of varying degrees of contamination because it is the key to the air flow patterns. The two basic principles in the design of air handling systems are to maintain the flow of air away from the clean or less contaminated space toward the space of greater contamination, and to utilize 100% outside air. Proper direction of air flow and dilution alone will not remove all microorganisms from an area, nor do they completely isolate spaces. Therefore, auxiliary devices such as filters, U.V. (ultraviolet) barriers, air locks, and incinerators are located strategically in the laboratories or in the air handling systems to facilitate elimination of airborne microorganisms.

All laboratories, work spaces and administrative spaces are air conditioned utilizing mechanical refrigeration. Year round temperature and humidity control is provided for animal rooms.

B. Functions of Air Handling Systems

Properly designed and balanced air handling systems and their auxiliaries accomplish the following special functions in biological laboratories:

1. Prevent the gradual build up of concentrations of microorganisms.

in the air.

2. Isolate spaces within the building.

3. Remove or destroy airborne microorganisms.

4. Prevent cross contamination between spaces.

5. Prevent the dissemination of infectious airborne microorganisms to the surrounding countryside.

6. Maintain design temperatures and humidities within the building.

C. Load Analyses

Load analyses shall be made to show load-time relationships. These analyses shall be used as a basis for determining concurrent loads, grouping of multiple spaces in zones, and characteristics of automatic temperature control systems. The analyses shall include load calculations at intermittent heating and refrigeration loads occurring during fall and spring to indicate the basis for equipment selection, control system design, and the incremental system effect of partial loadings such as those in animal rooms.

D. Zoning and Temperature Control

Administrative spaces having similar load-time characteristics may be supplied by a common zone with space temperature controller located in a representative space. Laboratories, work spaces, and animal rooms shall have individual room control.

E. Determination of Air Rates

The supply air rate to each space shall be determined by the requirement for internal loads, ventilation, or laboratory equipment, whichever is greatest. The minimum number of air changes per hour for ventilation is listed in Table 2.1, sub-section 2-03.

Unless otherwise approved by the Government, space volumes shall be based on gross interior space dimensions and shall neglect the volume occupied by columns, beams, equipment, piping, furnishings, and occupants.

2-02 AIR FLOW PATTERNS

A. Typical Air Flow Diagram: See Plate No. 2.1. This diagram does not include a liquid waste collection treatment room because the latter is not required in a typical laboratory building.

B. General Requirements

1. Isolation of Spaces: Separate air handling systems shall be

required to provide isolation between non-contaminated and contaminated spaces. Contaminated spaces may be served by one or more central supply and exhaust systems. Each biologically separated contaminated space shall be provided with an individual supply and exhaust system, or if more than one are served from one system they shall be isolated by high-efficiency filters in both the supply and exhaust duct systems.

2. No Recirculation: In contaminated spaces each air handling system shall be designed to utilize 100% outside air for heating, ventilation and air conditioning. General recirculation of air is prohibited. Non-contaminated spaces in which recirculation of air is permitted are specified in Table 2.1.

3. Direction of Flow: The established direction of flow shall be from less contaminated to more contaminated spaces and shall remain unchanged under all conditions.

4. Constant Flow: The air rate to each room shall remain reasonably constant. Air rates shall not be varied for purposes of temperature control.

C. Non-Contaminated Spaces

1. General: Heating, ventilation, and air conditioning shall be in accordance with normal practice.

2. Recirculation: Recirculation of conditioned air is permitted, but shall not include exhaust air from non-contaminated animal, cage washing, or glassware washing rooms.

3. Room Requirements: For air distribution requirements of individual non-contaminated rooms see Table 2.1, sub-section 2-03.

D. Contaminated Spaces

1. Negative Pressure: Contaminated spaces shall be maintained under negative pressure at all times with respect to the atmosphere and to non-contaminated spaces.

2. Supply and Exhaust Systems: The capacity of the exhaust system, fan, motor and drive shall be 20% greater than the capacity of the supply air system. The flow diagrams provided with the design shall be based on the total amount of supply air only.

3. Corridors: To maintain the corridors at higher pressure than the laboratories, corridors shall have air supply only, with uniform pressure throughout length of corridor.

4. Individual Rooms: Individual rooms shall be provided with separate supply and exhaust ducts, and individual temperature control.

Animal holding rooms shall have separate year round conditioned air control.

5. Room Requirements: For air distribution requirements of individual contaminated rooms see Table 2.1, sub-section 2-03.

6. Winter Heating: Design for winter heating shall provide means of minimizing the effect of the exterior, exposed wall surface.

2-03 DESIGN CONDITIONS

A. Outside Design Conditions: See 2-13 B, Fort Detrick Design Practices.

B. Inside Design Conditions: Table 2.1 lists the required conditions of temperature, humidity, and minimum air changes for each type of room, both contaminated and non-contaminated. Also listed, under "Remarks", are flow distribution conditions and various special requirements.

1. Temperature: Because of the thin work clothing worn in contaminated spaces, summer and winter temperatures shall be higher than in normal practice.

Table 2.1

Design Conditions for Interior Spaces

Item No.	Designation	Space Dry Bulb Temperature, °F Summer	Winter	Space % Relative Humidity	Minimum Air Changes per Hr	Remarks
1.	Non-Contaminated Laboratories, Offices, Conference Rooms, Lunch Rooms, Corridors, etc.	78	75	Summer 50 Positive control not required	6	Air circulation is permissible. Include hood or equipment exhaust in exhaust air changes. Provisions shall be made for maintenance of reasonably constant rate of exhaust from space through hood and equipment exhaust systems.
2.	Change Rooms	80-88 reset-able	80-88 reset-able	-	10	Clean change room shall be at negative pressure with respect to adjacent non-contaminated spaces and at positive pressure with respect to contaminated change room. The clean change room shall have no exhaust openings, and shall exhaust through shower room into contaminated change room. Provide supplementary heating in change and shower rooms to meet temperature requirements.
3.	Contaminated Offices	78	75	Summer 50 Positive control not required	6	Supply from contaminated space supply system. Exhaust by general contaminated space exhaust system. Provide for exfiltration to contaminated corridor.
4.	Contaminated Corridors	78	75	-	6	Supply from contaminated space supply system. Exhaust by exfiltration only to adjoining spaces of higher contamination level.

5.	Contaminated Laboratories	78	75	Summer 50 Positive control not required	6	Supply from contaminated space supply system. Exhaust by general contaminated space exhaust system and through hood and equipment exhaust systems. Provide for infiltration from contaminated corridor. Hood and equipment exhaust systems shall be designed to maintain constant exhaust from space.
6.	Animal Rooms	75-80 resettable	75-80 resettable	Summer 50 to 80 resettable Winter 50	15	Minimum supply air temperature shall be 55°F. Non-contaminated animal rooms shall be supplied and exhausted by non-contaminated space supply and exhaust systems, but exhaust air shall not be recirculated. All animal rooms shall have individual humidity controls, and roughing filters at room entrance to exhaust ducts. Provide for infiltration from adjacent corridor. Ventilation of all contaminated animal rooms shall permit use of both open cages and closed ventilated cages. See also 2-05 B.
7.	Glassware Washing and Cage Washing Rooms	-	75	-	15 See "Remarks"	Provide for space heat gain or 15 air changes per hour of conditioned air, whichever is least. Direct air to vicinity of operators. Provide hood to collect heat and moisture generated by equipment. In non-contaminated rooms the hood shall exhaust directly to outdoors without being filtered. In contaminated rooms the hood shall discharge into main exhaust system using precautions to prevent damage due to condensation. See also 2-05 C.
8.	Utility Rooms and Attic	101 max.	50 min.	No Requirement	2 summer and winter	Machinery and general space in basement and attic space shall be provided with filtered outside air for ventilation, with air changes calculated from equipment heat release and heat gain through walls and roof. Air is exhausted by exfiltration through screened and dampered roof caps or wall louvers. When mechanical exhaust is necessary, provide sufficient mechanical supply to maintain positive pressure and inter-lock electrically to prevent exhaust fan operation when supply fan inoperative.
9.	Air Locks	No Requirement				No supply or exhaust.

2-04 SUPPLY AND EXHAUST SYSTEMS, GENERAL

A. Typical Systems: See Plate No. 2.1 for diagram of typical supply and exhaust systems.

B. Location: The central supply and exhaust systems shall be located in a non-contaminated attic area.

C. Central Supply System

1. Prefilter: Prefilters shall be of the automatic renewable-media ("roll-up") type. They shall be controlled by automatic timers since pressure controllers have been found not sensitive enough for this application.

2. Preheat Coils: Preheat coils are a common source of trouble caused by corrosion or freezing, and this has been aggravated at Fort Detrick by the requirement for 100% outdoor air, and the frequency with which normal winter temperatures range up and down through the freezing point. For these reasons it is important to design and install the intake air and heating coil installation with great care to prevent freeze-up.

3. Cooling Coils: All chilled water air cooling coils shall be the completely drainable type. Coils shall have removable cast iron headers on at least one end, arranged so that each tube is individually drainable. A threaded plug shall be provided in the headers opposite each tube to facilitate cleaning. Each header shall be provided with a vent and drain plug. Tube interiors shall be prime surface with no interior fins or devices to increase water velocity.

4. Humidifier: Consideration shall be given, if requested by the Government, for provision of a humidifier in the central supply system. This would be designed to raise the humidity to a high level in a short time, for use in building decontamination with chemicals.

5. Bacterial Filter: Space for future installation of bacterial filters shall be provided because of the possible need for a germ-free environment in future work.

6. Alternate Systems: The supply system shown in Plate No. 2.1 employs reheat coils in supply ducts to individual rooms. This type of system has been generally used at Fort Detrick. Alternate systems, such as multizone systems with "blow-through" fan and coil equipment or double duct systems with constant volume mixing boxes, may be considered for specific installations. However, no design work shall be done on such alternate systems unless specific approval has been requested and received from the Government.

7. Separation of Supply and Exhaust: The building ventilation outside air inlets shall be separated as far as practicable from the points of exhaust. In selecting locations consideration shall be given to prevailing wind patterns of the geographical area. (At Fort Detrick it is preferable to locate exhaust discharges generally east of the air inlets; see 2-13 B).

8. Outside Air Intake: In the design of outside air intakes, consideration must be given to their continuous operation in adverse weather. Rain and snow must be baffled out of the air stream so it will not wet or clog the filter. Plenum floors must be water-tight and provide for drainage. Preheat coils and their associated controls and piping shall be designed and arranged to prevent them from freezing. Uniform air velocities across the face of louvers, filters and coils are essential. Baffle shall be installed to minimize effect of wind on air supply.

D. Central Exhaust System

1. Exhaust Fan: The main exhaust fan shall be equipped with variable inlet vanes, which shall be regulated by a static pressure controller to insure a reasonably constant negative pressure in all exhaust ducts as filter resistance changes.

2. Exhaust Stack

a. Velocity: The exhaust stack shall extend at least 5 feet higher than the highest point of the roof and shall provide a vertical uncovered discharge at a minimum velocity of 2,500 fpm.

b. Location: The exhaust shall be downwind (east) of the air inlets (see 2-04 C.6 above).

E. Room Ventilation

1. Individual Rooms: See Table 2.1.

2. Special Rooms: See 2-05 below.

3. Constant Air Flow: In order to insure a reasonably constant air flow rate to each room at all times (see 2-02 B.4), the following measures are taken.

a. Room Exhaust Pressure: A static pressure regulator in the main contaminated exhaust duct (see Plate No. 2.1) controls the exhaust fan inlet vanes to maintain constant exhaust pressure.

b. Operational Controls: Manual valve adjustments and automatic dampers are used to compensate for buildup of filter resistance in individual exhaust systems (fume hoods, safety cabinets, animal room exhaust, etc.).

c. Equipment Exhausts: The individual exhaust systems for all types of equipment are operated continuously (fume hoods, safety cabinets, etc.). Equipment exhausts shall be included in determining the minimum number of air changes per hour (see 2-01 E).

d. Fume Hoods: Fume hoods are equipped with automatic compensating devices to maintain constant exhaust flow from the room as hood opening is varied.

2-05 SPECIAL ROOMS

A. General: This subsection supplements Table 2.1, in which individual ventilation requirements for various types of rooms are listed in the column headed "Remarks."

B. Animal Rooms

1. Reference: See Table 2.1, Item 6.

2. Types of Room: See 1-05 C, ARCHITECTURAL.

3. Animal Cages and Cage Racks: For definitions and descriptions see 4-02, EQUIPMENT.

4. Ventilated Cage Racks: For the ventilation requirements of closed ventilated cages on racks see 2-07 B. and Plate 2.2.

5. Humidifier: The individual humidifier required for room humidity control may be located in the room or the attic, depending on the circumstances.

6. Constant Air Flow: To avoid variation in the room air flow when a cage rack is removed from the cage exhaust manifold, a fixed orifice is inserted in its place, as indicated on Plate 2.2. When only non-ventilated cages are used in the room, orifices are used in all manifold connections.

7. Air Motion: Air velocity shall not exceed 40 fpm in vicinity of open cages, to avoid drafts. Diffusers are not desirable. Exhaust should be located so that air in contact with animals will not be circulated past other animals.

8. Dust and Dirt: The air supply and distribution systems shall be designed to minimize the pickup and redistribution of animal hair, dust, and dirt. Filters that are easily serviced from the room shall be installed over the room exhaust openings. A roughing filter shall be provided in the cage rack exhaust manifold (see Plate 2.2).

9. Insulation and Vapor-Barriers: See 1-05 B.1, ARCHITECTURAL.

10. Emergency Ventilation System

a. Ventilated Suit Animal Room: If an emergency power system is available, then an additional roughing filter, HEPA filter, and fan (connected to the emergency power system) shall be provided to exhaust room air directly to the atmosphere (see plate 2.1).

b. Ordinary Animal Rooms: If blower for ventilated cage racks is on an emergency power system, then exhaust should discharge directly to atmosphere (see plates 2.1, 2.2).

C. Glassware and Cage Washing Rooms

1. Reference: See Table 2.1, Item 7.

2. General: Since the equipment used is a source of high heat and humidity, air conditioning to maintain comfort conditions is not economical or feasible. The present approach is to hood the equipment to remove as much heat and humidity as possible at the source, and to ventilate with a limited amount of conditioned air.

3. Preferred Location: See 1-02 B.8 and 1-02 B.9, ARCHITECTURAL.

4. Hooding of Glassware and Cage Washers: See 2-13 E.3.

D. Flammable Material Storage Rooms

1. Description: See 1-03 J, ARCHITECTURAL and Plate No. 1.13.

2. Exhaust Fan: The exhaust fan for the flammable materials storage room shall be spark-resistant (AMCA Type B) and shall have an explosion-proof motor.

E. Waste Collection Treatment Rooms

1. Reference: See 1-03 I, ARCHITECTURAL.

2. General: The liquid waste collection treatment unit (blowcase) is a large heat source in a contaminated area. To keep the room temperature to a tolerable level without requiring a large supply and exhaust capacity of filtered air, a water-cooled unit cooler is used, with air recirculated within the room. Make-up air to provide six air changes per hour may be supplied from the general contaminated space supply system, or a separate supply of filtered, non-conditioned air may be considered if it is more economical. Capacity of the exhaust system shall be 110% capacity of the supply system, to provide a negative pressure.

3. Bacterial Filter: If a separate air supply system is provided, it shall include a high-efficiency bacterial filter, which shall be mounted so that it may easily be removed into the room it serves.

F. Refuse Incinerator Rooms: See 4-04 C, EQUIPMENT.

2-06 VENTILATION OF SAFETY CABINETS

A. Cabinet Types and Descripti... See 4-01 A, 4-01 C, and 4-01 E, EQUIPMENT.

B. Typical Diagram: See Plate 2.1.

C. Ventilation of Class I Cabinets

1. Individual Cabinets: Individual Class I biological safety cabinets shall each be equipped with a high-efficiency bacterial filter (see 2-09 C) attached to the cabinet, and a fan located in the attic. The fan shall

discharge into the central exhaust system upstream from the central exhaust bacterial filter.

2. Array of Cabinets: Class I Biological Safety Cabinets joined together in an array shall each have a bacterial filter (see 2-09 C), from which the exhausts shall be manifolded to a single exhaust fan discharging to the main building exhaust.

3. Constant Flow: The cabinet exhaust blower operates continuously to maintain constant air flow from laboratory rooms. When a Class I cabinet is used with the front closed, greatly reducing the cabinet air flow, a by-pass opening in the cabinet exhaust duct, downstream from the cabinet filters, keeps the blower flow rate constant.

4. Exhaust Ducts: Exhaust ducts shall be of galvanized sheetmetal with all joints and seams sealed pressure-tight (see 2-10 A).

5. Required Air Flow

a. The exhaust system shall be designed to provide air flow with a minimum velocity of 60 fpm through work openings. For design purposes it shall be considered that the glove panels will be removed. The exhaust system shall be designed to maintain the required air flow through the cabinet openings when the resistance of the bacterial filter gradually increases from 1 inch w.g. (clean condition) to 2 inches w.g.

b. Exhaust systems for double-sided Class I biological safety cabinets shall be designed upon the assumption that glove panels will be removed simultaneously from both sides of the cabinet.

c. When the cabinet is operated with gloves in the ports, the exhaust system shall maintain a cabinet pressure of minus ½ inch w.g. minimum.

6. Controls: See 6-04, INSTRUMENTATION.

D. Ventilation of Class III Cabinets

1. General: The Class III biological safety cabinet is the most important single piece of equipment in preventing laboratory infections at Fort Detrick. For a definition and description see 4-01 A and 4-01 E, EQUIPMENT. For a typical ventilation diagram see Plate 2.1.

2. Reduced Pressure

a. The fan motor on the exhaust system is the only power utilized to ventilate the Class III cabinet system. This assures that the cabinets will be maintained at reduced pressure.

b. The cabinet ventilation systems shall maintain at least 3/4 inch w.g. negative (less than laboratory atmosphere) pressure within the cabinet systems.

3. Inlet and Exhaust

a. The air inlet and exhaust connections to the cabinet system shall be located to avoid short circuiting and to provide even air distribution. A sweep of air shall be provided in a direction to be dictated by the process or equipment contained within the cabinets: e.g., exhaust connections shall be located directly above or as close as practical to sources of heat, uch as sterilizers, or to sources of high contamination.

b. Each air inlet and exhaust outlet in the cabinets shall be equipped with a diaphragm valve located at the ventilation connection on top of the cabinet to allow halogen leak-testing of the cabinets (see 4-18, EQUIPMENT).

c. When more than six cabinet units are connected together in one cabinet system, two or more sources of supply and exhaust will be used.

4. Flow Rate

a. The minimum ventilation rate shall be 10 air changes per hour (4 cfm per standard 30" x 40" x 34" cabinet unit), or sufficient to limit to 10 F the temperature rise due to internal heat load, whichever is greater.

b. The cabinet exhaust system shall be designed to maintain a minimum velocity of 50 fpm through a single open glove port. (In general, this requirement is met by the above-specified flow rate.)

5. Inlet Filter

a. The source of air for cabinet ventilation is the laboratory room air. It shall enter the cabinets through HEPA air filters attached to tne flanged openings provided on top of the cabinets. For details of the Standard Biological Safety Cabinet Inlet Filters see 2-09 D.1. Each filter will be installed between the globe or gate valve and the cabinet.

b. For special applications, Class III cabinets may be provided with a special atmosphere (inert gas, low humidity, etc.). In such cases the required flow rate may be less than 10 changes per hour; however, the inlet filter size shall be based on 10 changes per hour minimum.

c. Provision shall be made for sterilizing the inlet filter.

6. Exhaust Filter: All air exhausted from Class III cabinet systems shall pass through HEPA filters (see 2-09 D.2); provision shall be made for sterilizing the filters. Each filter will be installed between the valve and the cabinet. Fittings shall be installed on each filter to allow for in-place DOP testing.

7. Air Incinerator: The cabinet exhaust air shall pass from the exhaust filter to an incinerator. See 4-04 A and B, EQUIPMENT.

8. Exhaust Pipe Lines

a. The exhaust air from Class III cabinets is carried in pipe with gastight welded joints, conforming with the requirements listed in subsection 2-08, Contaminated Vent System to Incinerator (CVI).

b. The pipe lines carrying air exhausted from Class III cabinet systems shall be pitched to drain toward the cabinets and shall be arranged in a manner to avoid pockets or traps.

c. If an array of cabinets is equipped with gastight isolation doors, each isolated section of cabinets is considered a separate cabinet system and no two sections may be manifolded together.

9. Instrumentation

a. See also 2.11 F, and 6-04, INSTRUMENTATION.

b. Magnehelic-type gages for indicating negative pressures between 0" and 4" H_2O shall be provided in sufficient numbers and in locations to permit observation of the pressure at any time in any cabinet. It is not necessary to provide gages for every cabinet unit, but gages should be provided for each isolated section of a cabinet system that will be under the same condition of pressure at all times.

c. Each isolated cabinet section shall be provided with an alarm device that indicates with a light and a buzzer when the internal pressure of the section reaches minus ½ inch w.g. The buzzer shall sound continuously only when the condition exists, but the light will remain lighted until manually extinguished.

10. Class III Envelope: The Class III designation is restricted to safety cabinet systems as defined above. In the past the concept has been applied occasionally to such cases as chambers, tanks, or rooms that provided a "gastight" envelope. This usage has been discontinued, and in the case of rooms is replaced by the Ventilated Suit Area (see 1-03 B, ARCHITECTURAL).

E. Ventilation of Laminar Airflow Safety Cabinets

1. Filters: HEPA-type filters only are used for both the recirculating air and the exhaust air. These filters must be checked by the dioctyl phthalate (DOP) standard test when the cabinet is received and installed and after filters are changed.

2. Air Exhaust: In general, the exhaust air will be discharged through the HEPA filter into the laboratory room. In a few special installations that will be specified, the exhaust air will be directed through a duct to the building exhaust system. The volume of exhaust air will be between 10 and 20% of the volume of the recirculated air.

3. Air Velocity: The downward air flow at all points within the cabinet should be 100 lfm ±20%.

4. Sterilization: Before HEPA filters are changed, the cabinet, including filters, should be sterilized. This sterilization is best accomplished by using formaldehyde gas generated from paraformaldehyde. A flexible duct (e.g., polyvinyl) should be run from the exhaust opening of the cabinet to the exhaust grill of the laboratory room to prevent formaldehyde from entering the room during formaldehyde generation and during aeration of the cabinet after sterilization.

2-07 VENTILATION OF OTHER SPECIAL EQUIPMENT

A. Scope: This subsection covers the ventilation of special equipment other than safety cabinets. For ventilation of Special Rooms see 2-05.

B. Ventilated Animal Cage Racks

1. Diagrams: See Plates 2.2 and 4.8.

2. Flow Rate: The exhaust system shall exhaust 37 cfm per four-tier cage rack and 2 cfm per monkey cage.

3. Pressure: The hose connection to cage racks shal be maintained at a negative pressure of 5 inches w.g.

4. Exhaust Ducts and Pipes: Exhaust manifold in the room shall be of galvanized sheetmetal with all joints and seams pressure-tight (see 2-10 A). Exhaust headers in chases and attic spaces shall be constructed of 18-gage black sheet steel with all joints and seams welded.

5. Pitch: Exhaust manifold shall pitch ¼ inch per 10 feet toward the cage racks.

6. Exhaust Filter: Exhaust air shall pass through a high-efficiency filter (see 2-09 C) and fan located in attic. Fan shall discharge into central exhaust system upstream from the central exhaust bacterial filter.

C. Chemical Fume Hoods and Radiological Hoods

1. General: Exhaust system equipment for chemical fume hoods and radiological hoods shall be of vertical, floor-mounted type consisting of a welded black iron casing painted on the inside with corrosion-resistant paint, high-efficiency particulate filter (see 2-09), and centrifugal exhaust fan (see Plate 2.1).

2. Ducts: Ducts shall be chemical- and corrosion-resistant and sealed pressure-tight. Ducts shall be arranged to avoid condensation or traps.

3. Exhaust Fans: Exhaust fans shall be centrifugal, with cast iron housing and non-sparking wheel. A 3/4-inch trapped drain to a CCD line shall be installed in bottom of the scroll. Fans shall be provided with vibration-isolation bases. No litharge-glycerin cement shall be used on the exhaust fan housing or any other parts of the exhaust system.

4. Flow Rate: The exhaust system shall be designed to produce a linear flow of 60 fpm across the front of hood with sash raised.

5. Constant Air Flow: See 2-04 E.3.

6. Exhaust Line: Exhaust line shall go directly from fan located in attic to outside through roof.

D. Refuse Incinerator: See 4-04 C, EQUIPMENT.

2-08 CONTAMINATED VENT SYSTEM TO INCINERATOR

A. Application: In general, air from exposure chambers and process equipment in which aerosols of infectious or toxic substances are formed or are likely to occur will be exhausted through the CVI (contaminated vent incinerator) system. Also, any item of equipment having waste connections to a liquid waste collection treatment unit will be vented to the CVI system. The following list, not necessarily all-inclusive, includes equipment from which air is exhausted or vented to the CVI system.

1. Waste collection treatment units.

2. Class III biological safety cabinets.

3. Plumbing vents on equipment connected to Class III biological safety cabinets.

4. Air-wash unit on sterilizers connected to Class III biological safety cabinets.

5. Vacuum discharges from equipment connected to Class III biological safety cabinets.

6. Discharge from safety valves on sterilizers that are attached to Class III biological safety cabinets.

7. Discharge air from process equipment.

8. Aerosol chambers.

B. Steam-Out Connections: Provide block valves and steam connections in CVI lines before leaving the building to permit steaming out the CVI system. Facilities and connections for halogen leak-testing should also be provided.

C. Materials and Accessories: See 3-04 F.4, PIPING.

2-09 BACTERIAL FILTERS

A. General: Bacterial filters are used primarily on exhaust lines carrying contaminated air or other gases. They are also used in some cases on air or gas inlets to provide a dust-free or germ-free atmosphere, or to protect the inlet line against possible contamination in case of accidental

reversal of flow. Where moisture and condensation can be present, a suitably resistant filter should be used.

B. Filter Efficiency: Two classes of bacterial filter (in addition to roughing or pre-filters) are used at Fort Detrick:

1. HEPA (Absolute) Filters: HEPA filters will remove a minimum of 99.97% of biological particles, 0.3 micron or larger from air, as determined by the standard DOP method, MIL-STD-282.

2. High-Efficiency Filters: High-efficiency filters have a nominal efficiency of 95% for removal of 1- to 5-micron or larger biological particles from air.

3. Seals: For filters of such high efficiency, it is particularly important, both in tests and in actual service, to insure against leaks through the seal around the filter frame.

C. Filter Media

1. Non-Combustible: Media for bacterial filters shall be non-combustible and suitable for service at temperatures up to 600 F.

2. Humidity: HEPA filters shall be suitable for service with air at 100% relative humidity at room temperature.

3. Media Types: Media to be used in bacterial filters are not restricted except by performance requirements. However, a brief description follows of types that have given satisfactory performance in past and current use.

a. Media for High-Efficiency Filters: For so-called deep-bed and other high-efficiency filters, the most commonly used media have been mats of glass fibers lightly bonded with phenolic resin. Type I medium employs superfine fibers (1.28 microns or less in diameter) and has a nominal efficiency of 99%, as defined above. It is often used in series with Type II medium, which employs fine fibers (averaging 2.54 microns in diameter) and has an efficiency of about 60%.

b. Media for HEPA Filters: The commonly used media for HEPA filters are glass or glass-asbestos paper, using a continuous sheet folded into closely spaced pleats, and integrally sealed into a factory-constructed frame.

D. Filters for Class III Safety Cabinets

1. Inlet Filter

a. For required use see 2-06 D.5.

b. The safety cabinet inlet filter employs a HEPA medium (see 2-09 B.1). For details of filter design see Fort Detrick Drawing F93-1-6419, sheet 1 of 2.

2. Exhaust Filter

a. For required use see 2-06 D.6.

b. The safety cabinet exhaust filter employs a HEPA medium (see 2-09 B.1). For details of filter design see Fort Detrick Drawing F93-1-6419, sheet 2 of 2.

E. Filter Sterilization: Bacterial filter sections installed in plenums or casings shall be equipped with a steam-formaldehyde spray system for sterilization. Steam and formaldehyde shall be supplied at a point as far as possible upstream of the filters through a connection on the casing by means of an ejector system as shown on Plate 2.3. Ejectors shall be of the steam-operated type.

2-10 METHODS AND MATERIALS

A. Exhaust Ducts

1. Exhaust ductwork carrying contaminated air through non-contaminated areas shall be made pressure-tight (as determined by soap bubble test at ~~+4~~ inches w.g), including all joints and seams.

2. Contaminated exhaust ducts that run outside of a building will have soldered or welded joints and will pitch to a contaminated drain. The exterior of such ducts will be painted with a weather-resistant coating.

B. Caulking of Duct Penetrations

1. Ducts passing through floors or through walls separating areas of different contamination levels shall be sealed as specified in 1-05 E, ARCHITECTURAL.

2. Where ducts pass through walls or partitions within the same level of contamination or in non-contaminated spaces, special sealing shall not be required, except for grouting and caulking.

C. Caulking of Accessories: Caulking of casing flanges on floors, around duct openings, filter frames and supports, louvers, etc. shall be done with Construction Grade Sealing Compound, as specified in 1-06 A.1, ARCHITECTURAL.

D. Exhaust Plenum: The bacterial filter section in the exhaust system shall be set on a waterproof concrete drain pan having a 4-inch-high curb around its perimeter (see subsection 3-04 B. 7b, PIPING). Building exhaust ducts shall not enter through the drain pan. See also 2-13 E.1.

E. Insulation

1. Piping insulation, see 3-06, PIPING.

2. Supply ductwork beginning at the cooling coil shall be insulated in the attic, utility spaces, and other unconditioned spaces.

3. All insulation, vapor-barrier, and duct-lining materials shall be noncombustible as defined in section 200 of the National Building Code, shall have a flame-spread rating of not more than 15-20, a fuel-contributed rating of not more than 20-35, and a smoke-developed rating of not more than 0, as defined in the Method of Test of Surface Burning Characteristics in the Building Materials List of the National Fire Protection Association.

4. Where insulation ducts are subject to washdown, they shall be covered with a finishing jacket of 8-ounce canvas, cemented in place with lagging cement and covered with two coats of lagging cement. The lagging cement shall be of the polyvinylacetate type. For finish painting see 1-06 C, ARCHITECTURAL.

2-11 CONTROLS

A. Scope: This subsection is limited to special criteria based on biological safety considerations. Additional information will be found in Section 6, INSTRUMENTATION.

B. General: The control system shall be of the electric or pneumatic type. The control system shall operate year-round without any seasonal change-over.

C. Central Ventilation System (Contaminated): The air supply system to be controlled consists of a prefilter, preheat coil, cooling coil, supply fan, and room reheat coils. The exhaust system to be controlled consists of a bacterial filter, exhaust fan, and a pressure control system that operates fan inlet radial blade dampers to compensate for filter resistance changes (see Plate 2.1). See also 2-04 C.5 for alternative systems.

1. The exhaust fan must be started before the supply fan can function.

2. The supply fan shall cease operation when the exhaust fan stops.

3. All building main exhaust and attic ventilation shall be capable of being shut off by a switch located outside the building in accordance with 5-08 D.4, ELECTRICAL.

4. Room pressure shall be established at the required levels by initial manual balance of air flows. Air flow resistance increase up to 1" w.g. through the bacterial filter shall be compensated for by the pressure control system modulating the exhaust fan radial blade damper.

D. Ventilation System (Non-Contaminated): Any exhaust fan serving the non-contaminated area shall cease operation when the supply fan stops.

E. Bacterial Filter Pressure Drop Monitoring: All bacterial filters, except for Class III safety cabinet inlet and outlet filters, shall be monitored with a differential pressure indicator of magnehelic type mounted on the outside of the filter casing across the bacterial filter bank.

F. Safety Cabinet Control

1. Class I and Class III Biological Safety Cabinets, and other safety cabinets shall not be interlocked with building central exhaust fan or fire alarm.

2. For Class III safety cabinet pressure alarm see 6-04 B, INSTRUMENTATION.

G. Fume Hood Control

1. Each chemical or radiological fume hood system shall have an individual exhaust system consisting of a bacterial filter and exhaust fan.

2. The hood exhaust fan shall be shut off when the building central exhaust fan is stopped.

3. Fume hood pressure shall be established at the required level by initial manual setting of the exhaust fan suction damper.

4. For constant-flow arrangement see 4-09 G.1, EQUIPMENT.

5. Air flow resistance across the bacterial filter shall be monitored by a differential pressure indicator.

H. Animal Room: Each animal room shall have its own system of temperature and humidity control, which is to be manually set.

I. Flammable Material Storage (In Contaminated Areas): Exhaust system shall consist of a normally open damper in wall and fan discharge duct, and an exhaust fan (see Plate 1.13). Exhaust fan shall be spark-resistant (AMCA Type B) with explosion-proof motor. Exhaust air shall discharge directly to atmosphere through high-efficiency filter if space is in contaminated area.

1. Both the damper and fan shall be interlocked with CO_2 system so that the damper closes and the fan ceases operation when the CO_2 system is actuated.

J. Clean Change Room Temperature Control: Each clean change room shall have a means for independent temperature regulation. See Table 2.1, Item 2.

2-12 TESTING AND BALANCING

A. All air handling systems shall be tested and balanced, using the services of an independent air balancing and testing agency. The balancing shall be done with all building supply and exhaust fans in operation. The proposed testing and balancing procedures shall be submitted for prior Government approval.

2-13 FORT DETRICK DESIGN PRACTICES

A. Scope

1. This subsection contains criteria and design information not related to biological safety considerations and is not intended to be comprehensive.

B. Outside Conditions, Fort Detrick, Frederick, Maryland

1. Latitude 39°-25"
2. Elevation 325 ft.
3. Temperatures:
   - Summer: 91 F dry bulb
     76 F wet bulb
     78 F wet bulb (cooling tower design)
   - Winter: 5 F, dry bulk (for load computation)
4. Daily Temperature Range:
   - Summer: 20 F
5. Wind Speed:
   - Summer: 10 mph
   - Winter: 15 mph
6. Prevailing Wind Direction: West.
   - Summer: SW
   - Winter: NW

C. Heat Gains from Equipment and Animals

1. Autoclaves, through partitions - hooded, both sides (sensible heat to rooms).

Size	Large Extension	Small Extension
16" dia. x 24" long	1500 Btu/Hr	920 Btu/Hr
20" dia. x 36" long	3000 "	1880 "
16" x 16" x 24" long	1860 "	1160 "
24" x 24" x 36" long	6000 "	3800 "
24" x 36" x 48" long	8250 "	5100 "
36" x 42" x 72" long	14000 "	8700 "
48" x 54" x 96" long	21500 "	13400 "

2. For heat gains from animals and cage racks see Table 2.2.

Table 2.2 Heat Gains From Animals

Animals	Ave. Weight, Lb.	Btu/Hr/Animal S.H.+	Btu/Hr/Animal L.H.+	Animals Per Rack	Open Cages Without U.V. Btu/Hr/Rack S.H.	Open Cages Without U.V. Btu/Hr/Rack L.H.	Open Cages With U.V.* Btu/Hr/Rack S.H.	Open Cages With U.V.* Btu/Hr/Rack L.H.
Guinea Pigs	0.9	3.3	1.7	40	132	68	682	68
Mice	0.05	1.4	0.7	640	896	448	1446	448
Rabbits	5.7	21.1	10.6	24	506	254	1056	254
Rats	0.7	2.8	1.2					
Monkeys	7.0	20	10					
Cats	6.6	18	6					
Chimps	30	60	30					
Dogs	25	50	25					
Sheep	140	200	80					
Swine	250	320	100					
Burro	400	450	150					
Ponies	600	600	200					
Horses	1200	1050	350					

* U.V. contributes 550 Btu/Hr/Rack, based on 20 watts per U.V. lamp. For ventilated cages, heat load is from U.V. only, and is 550 Btu/Hr/Rack.

\+ S.H.=sensible heat; L.H.=latent heat.

D. List of Components

1. Central Supply System

Prefilter
Preheat Coil
Cooling Coil
Supply Air Fan
Space for Future Installation of Bacterial Filters
Ductwork for Distribution
Reheat Coils

2. Central Exhaust System

Registers
Ductwork
Static Pressure Regulator to Control Fan Inlet Vanes
Connections for Decontaminating Filters
Bacterial Filter
Exhaust Air Fan

E. Plenums and Casings, Housings and Accessories

1. Plenums and Casings: Plenums and casings shall be fabricated of minimum 18 gage galvanized iron sheetmetal. Exhaust plenums and casings shall be riveted to a welded integral angle iron frame to witnstand pressures up to ± 5 inches w.g. Sheetmetal joints shall be riveted on maximum 4 inch centers and shall be soldered pressure tight. Internal surfaces of the casing shall be painted with corrosion-resistant paint. Access doors shall be dogged and gasketed to insure pressure tightness. All plenums and casings shall be provided with a 10-gage galvanized sheet

metal pan turned up six (6) inches on sides with all joints soldered. A two (2) inch concrete bearing surface shall be poured in the pan.

2. Autoclave Exhaust Hoods (for autoclaves 20" dia. x 36" long and larger).

a. Exhaust hoods shall be fabricated from minimum 20 gage sheetmetal and galvanized angle iron reinforcement where required.

b. Clearance at sides shall be adequate to permit operation of hand valves. Safety valve shall be visible.

c. Duct from hood shall connect to building central exhaust system.

d. A wall exhaust register connected to the duct near the ceiling shall be utilized to remove heat-laden air from the laboratory.

e. Insulation covering shall be painted before installing hood. One entire side of hood shall be removable. Paint interior of hood. Where several autoclaves are placed side by side, they shall be enclosed in one large hood instead of separate hoods.

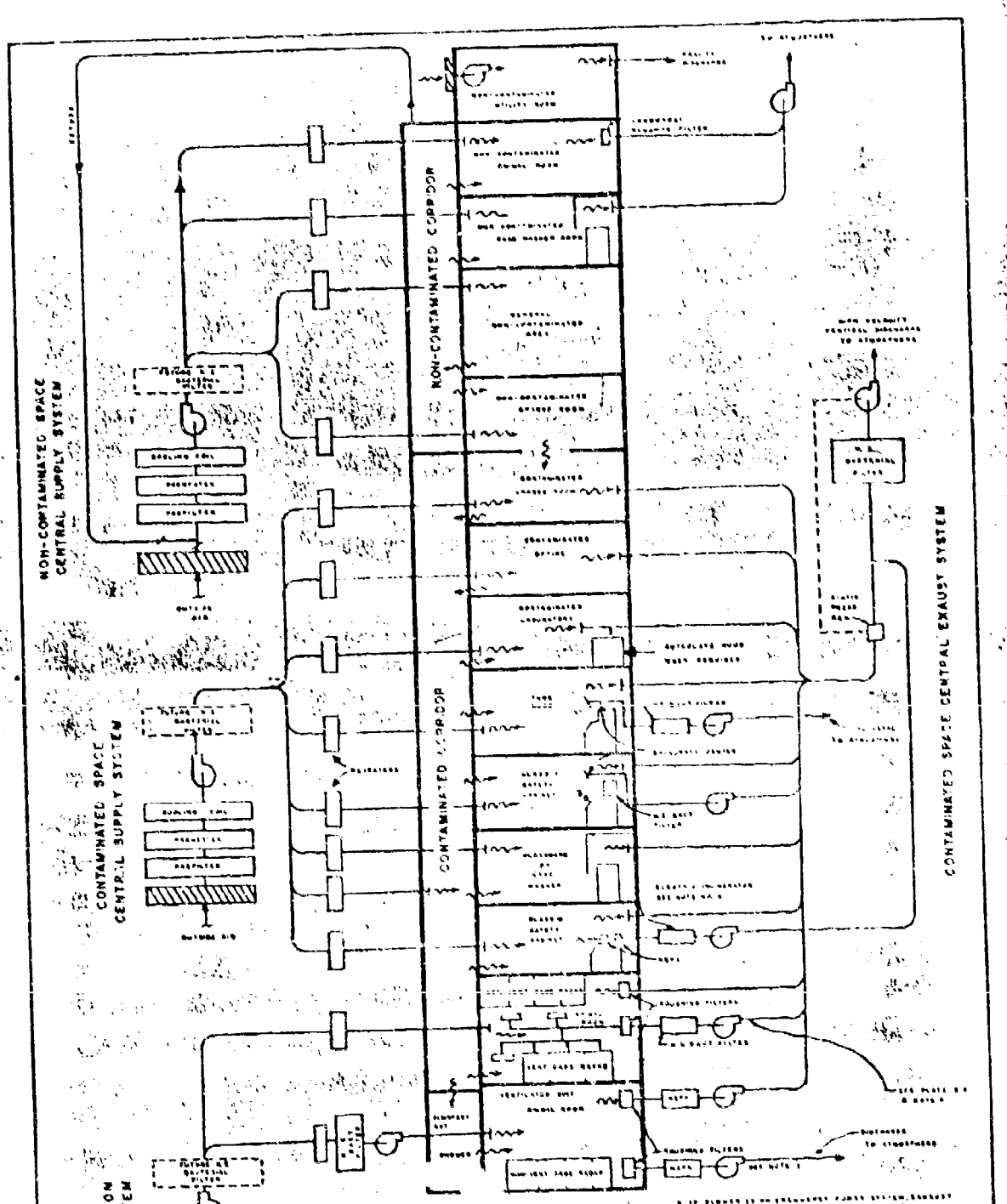
3. Hooding and Venting of Cage Washers and Glassware Washers

a. A sheetmetal hood shall be designed to confine and collect heat and moisture generated by the equipment. The hood shall have insulated side panels, but shall not interfere with the operation of the equipment.

b. In non-contaminated areas the hood shall have an exhaust blower which shall provide 50 fpm air velocity across load face area. In contaminated areas the hood will exhaust directly to the central exhaust system, without a separate blower.

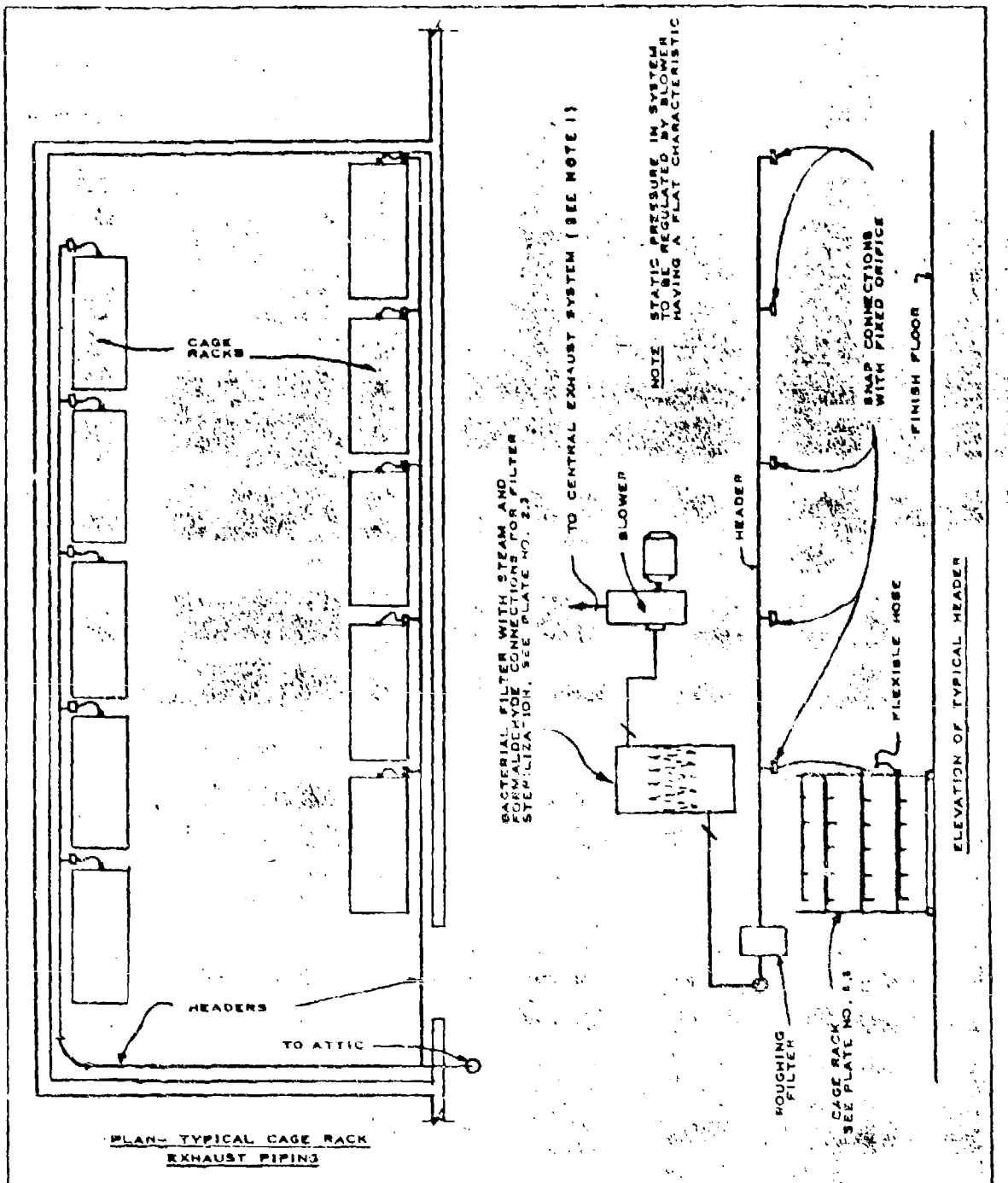
c. Air exhaust duct from the washer hood shall be galvanized with soldered joints and seams, and shall be pitched to drain back to the washer.

d. The blower, if required, shall be rustproof and accessible for service. The scroll shall be drilled and equipped with drain line back to the washer or other convenient drain.



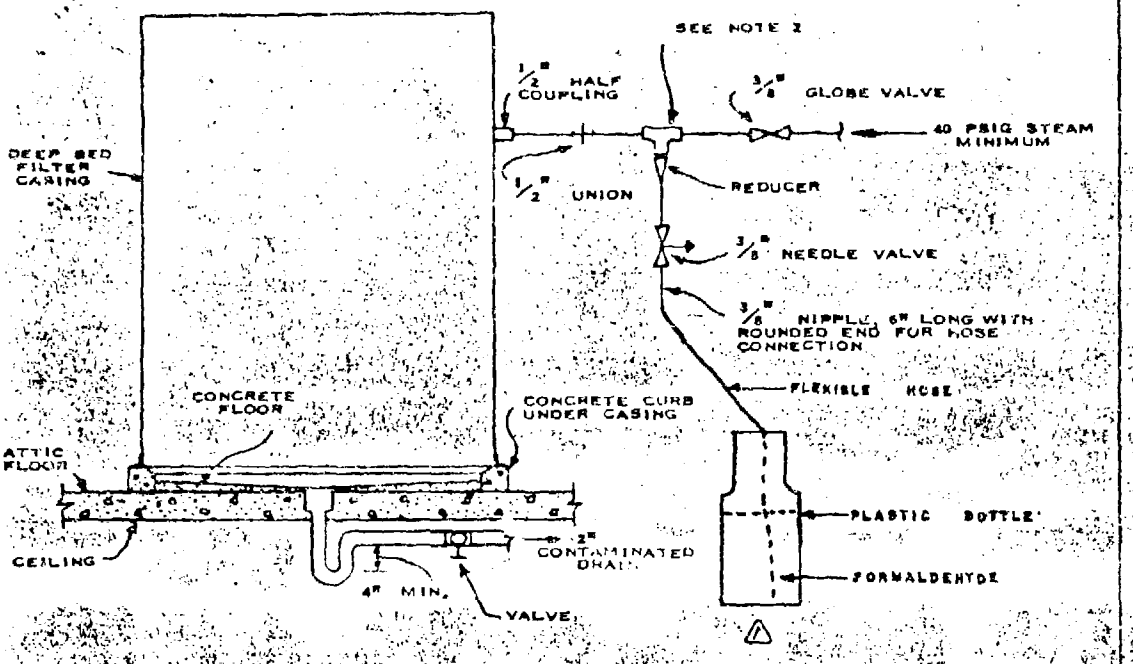
TYPICAL AIR FLOW DIAGRAM FOR CONTAMINATE BUILDINGS

REV.	DATE	DESCRIPTION
		GENERAL REVISION
	9 AUG 67	GENERAL REVISION
	DATE-1 FEB 66	PLATE NO. 2.1



⚠ NOTE 1. IF BLOWER IS ON EMERGENCY POWER SYSTEM, EXHAUST SHOULD DISCHARGE DIRECTLY TO ATMOSPHERE

TYPICAL EXHAUST SYSTEM FOR VENTILATED CAGES	REV.	DATE	DESCRIPTION
	⚠	9/69	ADDED NOTE 1
	DATE - 1 FEB. 66		PLATE NO. 2.2



NOTES

1. STEAM EJECTOR CONNECTION TO CASING SHALL BE LOCATED AS FAR AS POSSIBLE FROM FILTERS ON CONTAMINATED SIDE TO ALLOW FOR PROPER DIFFUSION.
2. EJECTOR, STEAM OPERATED TYPE, ALL BRONZE BODY, PENBERTHY, SERIES IA.
3. METAL DRAIN PAN MAY BE SUBSTITUTED FOR CONCRETE BASE IF APPROVED BY THE GOVERNMENT.

STERILIZATION OF DEEP BED FILTERS WITH STEAM–FORMALDEHYDE	1	9/69	ADDED PLASTIC BOTTLE
	REV.	DATE	DESCRIPTION
	DATE – 1 FEB. 66		PLATE NO. 2.3

4/70

SECTION 3 - PIPING

TABLE OF CONTENTS

Page No.

Page No.

LIST OF PLATES

SECTION 3

PIPING

3-00 INTRODUCTION

A. Scope

This section is addressed primarily to those architect-engineering personnel concerned specifically with the engineering and design of piping for microbiological facilities at Fort Detrick. It applies to new facilities and to modifications and additions to existing facilities.

B. Organization of Section 3

The remainder of this section is divided into the following main sections:

1. General
2. Service Piping
3. Process Piping
4. Waste Piping
5. Fire Sprinklers
6. Insulation
7. Marking and Color Code

3-01 GENERAL

A. Categories of Piping

1. Service Piping: Service piping includes all contaminated and non-contaminated services.

2. Process Piping: Process piping is used for the transfer of agent material between process systems.

3. Waste Piping: Waste piping, including drains and vents, is divided into sanitary waste and contaminated waste.

B. List of Piping Services: Table 3.1, subsection 3-07, lists the names, symbols, and color codes of the various piping services. Color codes not found in this list will be found in ASA, A 13.1.

C. Piping Guide: A guide of material requirements for services, covering piping and tubing, valves, fittings, etc., is given in Appendix C. Recommendations by architect-engineers shall be made when cost, life expectancy, corrosion, or project requirements warrant other materials of construction.

D. Piping Code: General piping shall conform to the National Plumbing Code as detailed in ASA, A 40.8, except as outlined below.

E. Bypass Loops: Bypass loops shall be installed in all main headers to facilitate corrosion testing.

3-02 SERVICE PIPING

A. General

1. Three Categories of Service Piping

a. Contaminated services that serve the contaminated areas of the building. Examples are listed below. It should be noted that the designation "Contaminated Service" does not mean the service itself is biologically contaminated (with the exception of CVA which is potentially contaminated) but only that the service is located in and services a contaminated area.

CCW Contaminated Cold Water Service
CHW Contaminated Hot Water Service
CVA Contaminated Vacuum Service
PRA Process Air (Contaminated)
DPRA Dry Process Air (Contaminated)

b. Non-contaminated services that are the same type of services as the contaminated services, but serve only the non-contaminated areas of the building. Examples are:

NCW Non-Contaminated Cold Water Service
NHW Non-Contaminated Hot Water Service
NVA Non-Contaminated Vacuum Service

c. All remaining services that may serve either the contaminated or non-contaminated areas of the building. Examples are:

CA Compressed Air
DCA Dry Compressed Air
MA Mask Air
IA Instrument Air
PG Propane Gas
100-S 100# Steam
60-S 60# Steam
10-S 10# Steam
DW Drinking Water
DIW Distilled Water
DMW Deionized Water
N Nitrogen
T Decontaminant

2. Valving Requirements

a. Shut-Off Valves. Shut-off valves are required on all branch lines at the headers. Valves are also required on all branch lines entering rooms. All valves must be placed in accessible locations.

b. Diaphragm Valves: Diaphragm type valves are specified for several types of contaminated service (see Appendix C) because of their leak-tight design and suitability for decontamination. Where installation of diaphragm valves is required, they shall be located in a vertical run of the line whenever possible in order to minimize pocketing of the liquid within the valve. When installation is required in a horizontal run of the line, the stem of the valve shall be turned so as to be 15 degrees above the horizontal plane.

c. Foot-Operated Valves: Foot-operated valves are required for all drinking fountains (no hand-operated valves are permitted). On all wash bowls on the contaminated side of the change rooms, foot- or knee-operated hot and cold water valves that are not rodent harborages shall be installed.

d. Elbow-Operated Valves: In at least one (1) sink in each autopsy room, water control shall be by means of elbow-operated valves. These permit turning the faucet to run at a constant rate, which cannot be done with a foot pedal.

e. Shower Valves: Change room shower valves shall be of the single unit mixing type, thermostatically controlled. The valves shall be "non-scalding," having pressure equalizing features to allow for sudden pressure fluctuations in the water supply. Strainers shall be installed in the hot and cold water supply lines to the shower valves. No valves shall be installed after the shower control valve.

f. Solenoid Valves: Where pressurized gas systems such as air or nitrogen enter biological safety cabinets or process equipment, they shall be equipped with a solenoid valve controlled by a differential pressure switch on the equipment. The solenoid valves shall be the normally closed type to prevent pressurization in the event of a power failure. Solenoid valves should be preceded by a fine mesh strainer to prevent clogging (see Plate 6.1).

g. Distilled Water Valves: Distilled water outlets shall be equipped with spring-loaded valves.

3. Location of Equipment

a. Unless otherwise specified, the equipment required to provide services for the building, such as compressors, pumps, etc., shall be located in the mechanical equipment room.

4. Services to Special Equipment: The following tabulation lists the piping services normally required for safety cabinets and special equipment. For electrical services see 5-04, ELECTRICAL.

	Hot Water	Cold Water	Propane Gas	Vacuum	Compressed Air	10# Steam	60# Steam	100# Steam
Biological Safety Cabinet, Autopsy	X	X	X	X	X	b		
Biological Safety Cabinet, Class I	X	X	X	X	X	b		
Biological Safety Cabinet, Class III	X	X	a	X	X	b		
Radiological Hood		X	X	X	X			
Chemical Fume Hood		X	X	X	X			
Cage Service Cabinet		X		X	X	b		
Refrigerators (Walk-In)				X	X			
Incubators (Walk-In)				X	X			
Steam-Gas Sterilizer (Combination Steam-Freon ETO Sterilizer)				X			X	
Steam Sterilizer							X	
Sterilizer, Mechanical Air Removal				c				X

NOTES:

a. Should propane gas be required to this equipment (to be specified by the Government), this line must be equipped with a "dead man" type, spring-loaded shut-off valve or an automatic timed (10 minute) type of shut-off valve. Wherever possible, portable canister gas supply, alcohol lamps, or electric heater shall be used in preference to the above.

b. 10# steam shall be provided for carrying out sterilization of cabinets with steam-formaldehyde (see Plate No. 3.1). The steam control valve should be within easy reach.

c. High vacuum must be supplied, either by mechanical or steam jet operation.

5. Miscellaneous

a. Safety Showers: Safety showers shall be equipped with a heavy-duty, quick opening, closing, piston type valve, and shall be installed directly above a floor drain. The safety shower shall be so located and equipped with a chain pull that if a person is temporarily blinded he can feel his way to the safety shower chain. The supply line to the safety shower shall be 1 inch and shall be connected to the non-contaminated water supply system. There shall be no valves installed in the 1-inch line between the quick-opening shower control valve and the main, non-contaminated water supply header. The shower head shall be an 8-inch deluge type with no voids in the flow. It shall be a self-cleaning, non-clogging type that will operate on unfiltered water supplies. The floor under the safety shower shall be painted green. A safety shower shall be installed in each laboratory containing a chemical fume hood or a radiological hood. In addition, one safety shower shall be installed in the contaminated corridor of each building above one of the corridor floor drains and on each floor of the building. A safety shower shall be installed in each dishwashing room in which provision is made for routine use of acid cleaning solution. If a contaminated corridor is separated by an air lock, there shall be a safety shower in each section of the corridor.

b. Hose Bibs: At least one 3/4-inch hose bib shall be provided in each contaminated corridor for washing the area. The hose bib station shall be provided with a hose hook and 50 feet of 5/8-inch I.D. garden type water hose equipped with a pistol grip nozzle. Additional stations shall be installed as required so that all areas can be serviced by 50-foot lengths of hose.

c. Swing Spouts: Swing spouts for water shall be used at all laboratory and glassware washing sinks.

d. Fire Sprinklers: See 3-05.

6. Installation Methods: Service piping shall be installed with sloping lines. The use of check valves should be considered to isolate branch water lines within a large, complex, multiscience laboratory building. To avoid crevices that might permit buildup of contamination, and to promote ease of painting and cleaning, piping should never be mounted in direct contact with a wall. Plate No. 3.2 indicates required spacing between pipe and wall, between adjacent pipes, and method of support, including the use of caulking compound to fill irregularities. Piping shall be supported at least 12 inches below the ceiling for ease of painting and cleaning and to facilitate top connections.

7. Seals Around Penetrations: For details on seals around pipes passing through walls, floors, etc., see 1-05 E, ARCHITECTURAL.

8. Special Requirements: Specific special requirements for the various piping services will be found in the following sub-sections. In general these requirements are for contaminated services. Non-contaminated services, unless otherwise specified, will be in accordance with normal practice.

B. Cold Water, Contaminated Service (CCW)

1. Purpose: Contaminated cold water (CCW) is provided for use in the contaminated areas of the building. For specific purposes CCW may be used in non-contaminated areas.

2. Application: CCW is used in laboratory sinks, glassware washing sinks, building washdown hose bibs, biological safety cabinets, process vessels, and all potentially contaminated areas (except as noted in 3-02 G).

3. Requirements:

a. Source: CCW shall be supplied through a break-tank water system to all pilot plant facilities, process development buildings, and aerobiological facilities. Standard microbiological and virological research laboratories, animal holding facilities, chemistry, biophysics, pathology, and crops research buildings shall be supplied with CCW through an approved type of back-flow preventer valve. At Fort Detrick, there is a primary break-tank system through which all water for the complex of laboratory buildings within the restricted area is supplied. An approved back-flow preventer valve should be of the type that has two (2) spring-loaded vertical check valves and one (1) spring-loaded, diaphragm differential pressure relief valve. A guide to selection of a suitable back-flow preventer valve is one that has been approved by the State of California Health Department (see Plate No. 3.3).

b. Measurement: Any building that is connected to the contaminated sewer shall have a water meter on the main CCW supply header.

C. Hot Water, Contaminated Service (CHW)

1. Purpose: Contaminated hot water (CHW) is provided for use only in the contaminated areas of the building.

2. Application: CHW is used in laboratory sinks, glassware washing sinks, biological safety cabinets, process vessels, and all other potentially contaminated areas (except as noted in 3-02 H).

3. Requirements:

a. Source: CHW shall be supplied to the building by an independent hot water heater supplied by the building CCW system.

D. Vacuum, Contaminated Service (CVA)

1. Purpose: Contaminated vacuum service (CVA) is provided for use only in the contaminated area of the building.

2. Application: Contaminated vacuum outlets are used on all laboratory bench tops and glassware washing rooms. (See 3-02 A.4 for additional locations.)

3. Requirements:

a. Capacity: Requirements at each service outlet shall be 5 cfm at 20 inches of mercury vacuum, unless otherwise specified.

b. Demand Factor: A demand factor of 10% of the total connected load shall be used for design.

c. Source: The vacuum pump for the CVA system shall be located in the utility service area of the building and shall discharge through the contaminated vent to the incinerator system (CVI). If an incinerator vent system is not available, the exhaust shall be discharged to the building air exhaust plenum before the filters. There shall be a pipeline bacterial filter able to operate in a moist atmosphere on the vacuum line immediately before the line enters the surge tank. A water sealed pump shall be used as the vacuum source. The pump shall operate intermittently.

d. Distribution: Vacuum lines from individual stations shall be top-connected to the main vacuum header and be sloped to prevent entrained liquids from flowing back to other stations when the system is not in operation. The system shall be valved to permit sterilization of the entire system prior to entering the CVI header for maintenance of the pump. There should be adequate separation by filters of laboratory area from process area, and benchtop vacuum from Class III vacuum. The Government shall designate the autoclaves in the building that will be equipped to utilize ethylene oxide gas for sterilization purposes. Autoclaves so designated shall be connected to the CVA syst as shown in Plate No. 3.4 and Plate No. B.1.

E. Process Air (PRA)

1. Purpose: Process air (PRA) is provided for use in the contaminated areas of the building. A PRA system will be required in buildings such as pilot plants and process development buildings.

2. Application: PRA is used only for service in direct contact with the interior of contaminated process equipment or systems.

3. Requirements:

a. Source: An independent supply shall be provided for the PRA system that shall be from an oil-free carbon or Teflon® ring compressor. Dew point, temperature, pressure, and flow rate shall depend upon the specific application.

b. Distribution: Prior to entering the vessel or other equipment where the air will come in direct contact with the agent, the air line shall be equipped with a bacterial filter and adequate valving to permit steam sterilization of the filter and the pipe downstream of the filter. The main air header shall be equipped with a bacterial filter downstream of the system pressure regulator with a shut-off valve between the filter and the pressure regulator to permit steam sterilization of the entire system.

F. Dry Process Air (DPRA)

1. Dry process air shall be supplied by passing process air (PRA) through a drier. For application, see 3-02 E.2.

2. The temperature, dew point, and flow rate shall be determined by the specific application.

3. For drier details, see 3-02 K.3.

G. Cold Water, Non-Contaminated Service (NCW)

1. Purpose: Non-contaminated cold water (NCW) is provided for use in the non-contaminated areas of the building except as noted below.

2. Application: NCW is used for lavatories, water closets, change rooms, showers, safety showers, and fire sprinklers in the non-contaminated and contaminated areas of the building. This service is not used for drinking water (see 3.02 P).

3. Requirements:

a. Source: The supply for this system shall be taken off the main header prior to the break-tank or back-flow preventer used for the CCW service. See Plate No. 3.5.

b. Measurement: Each building shall have a water meter on the main non-contaminated water supply.

H. Hot Water, Non-Contaminated Service (NHW)

1. Purpose: Non-contaminated hot water (NHW) is provided for use in the non-contaminated areas of the building except as noted below.

2. Application: NHW is used for lavatories and showers in the non-contaminated and contaminated areas of the building.

3. Requirements.

a. Source: NHW shall be supplied by a separate hot water heater supplied by the building NCW system. The tap for the supply system shall be after the NCW water meter.

b. Distribution: The hot water system shall be a closed-loop forced recirculating type.

I. Vacuum, Non-Contaminated Service (NVA)

1. Purpose: Non-contaminated vacuum service (NVA) is provided for use only in the non-contaminated area of the building.

2. Application: Non-contaminated vacuum shall be provided for benchtop use and in gas sterilizers in non-contaminated laboratories.

3. Requirements:

a. Capacity: Requirements at each outlet shall be 5 cfm at 20 inches of mercury vacuum unless otherwise specified.

b. Demand Factor: A demand factor of 10% of total connected load shall be used for design.

c. Distribution: Vacuum lines from individual stations shall be top-connected to the main vacuum header and sloped to prevent entrained liquids from flowing back to the stations when the system is not in operation. Headers whenever possible shall be sloped toward the source. If the requirement for NVA is limited that separate service cannot be justified, a tie-in to the general CVA system should be made and the NVA isolated with a pipeline bacterial filter. Discharge of air in this instance shall be as outlined above in 3-02 D.3.c.

J. Compressed Air (CA)

1. Purpose: The compressed air system (CA) provides general compressed air services for both the contaminated and non-contaminated areas of the building.

2. Application: Compressed air outlets are used on laboratory benches, in ventilated cabinets and in glassware washing room. (See 3-02 A.4 for additional locations.)

3. Requirements:

a. Source: The compressed air (CA) shall be supplied by an oil-free carbon or Teflon® ring type compressor. The compressor will operate intermittently to give 60 to 70 psig in the receiver, which will be reduced by a pressure reducing valve in the line after the receiver to maintain 40 psig at the most remote station.

b. Capacity: Requirements are 5 cfm at 40 psig at every station. A demand factor of 10% of total connected load will be used in general for design purposes. Spacing factors will be designated by the Government.

K. Dry Compressed Air (DCA)

1. Purpose: The dry compressed air system (DCA) provides service for the contaminated and non-contaminated areas of the building.

2. Application: DCA is supplied primarily for use in special Class III biological safety cabinet systems where humidity control is required (see Plate No. 6.1).

3. Requirements:

a. Source: DCA shall be supplied by passing air from the CA system through a suitable desiccant drier. The drier should be a fully automatic reactivating type with temperature limitation protection.

b. Capacity: Pressure, dew point, and rate shall be determined by the specific application.

L. Mask Air (MA)

1. Purpose: The mask air system (MA) is provided to supply breathing air for ventilated suits and head hoods used in the contaminated areas of the building.

2. Application: A minimum of three (3) MA outlets shall be provided in every room housing ventilated animal cages, aerosol tanks or chambers, and particularly hazardous apparatus such as spray driers, large lyophilizers, extraction columns, large filtration apparatus, centrifuges, mixers, agent filling machines, and any other equipment designated by the Government. At least one (1) room in each contaminated building shall be equipped with a minimum of three (3) outlets.

3. Requirements:

a. Source: The MA shall be provided by a system consisting of two (2) oil-free carbon or Teflon® ring type compressors and shall be cooled and free of water condensation. The receiver shall be sized

with sufficient reserve capacity to handle one-half of the system outlets for a period of five minutes. In cases where an existing water sealed compressor is used as the source for MA, a positive means of removing chlorine from the MA shall be provided. This can be accomplished by means of a silica gel air drier in the air stream or a carbon filter in the seal water line.

b. Capacity: The Government will furnish the air distribution system pressure, temperature, flow rate, dew point and demand factor required.

c. Distribution: Branch lines shall be taken from the top of the main header. Each branch line shall be provided with a shut-off valve at the header, a strainer before the manifold, a drip leg, and quick opening drain cocks. The manifold shall consist of ½-inch half-couplings welded to the manifold on approximately three inch centers. Spring-clip type hose brackets shall be provided alongside each manifold and shall accommodate the same number of hoses as there are outlets on the manifold. Hose reels may be provided in mask air areas subjected to heavy traffic or where two or more people are required to work in the area for extended periods of time. Hose reels shall be the pull out and latch type with an adjustable hose tension feature and an emergency latch feature to prevent accidental rapid rewinding of the hose while still in use. Hose shall be 5/16-inch I.D. by 5/8-inch O.D. single braid red "beer" hose. Hook type brackets for supporting personnel hoods shall be provided in change rooms, air locks, or corridors.

d. Alarms: Low pressure alarms shall be provided locally.

M. Instrument Air (IA)

1. Purpose: The instrument air system (IA) is provided for use in both the contaminated and non-contaminated areas of the building.

2. Application: IA is used for the operation of pneumatically controlled instruments. It may also be used for the operation of pneumatic actuators, such as air cylinders, provided the proper oilers are added.

3. Requirements:

a. Source: IA shall be free of dirt. A standby compressor or tie-back to the compressed air system (CA) shall be provided to maintain service in the event of a breakdown of the main IA system.

b. Conditioning: The IA, where required, shall be dry and have a dew point of 0°F at atmospheric pressure.

c. Controls: A primary pressure regulator shall be provided after the receiver.

N. Propane Gas (PG)

1. Purpose: The propane gas system (PG) provides low-pressure gas to the contaminated and non-contaminated areas of the building.

2. Application: PG is supplied for laboratory bench tops, glassware washing tables, Class I biological safety cabinets, and Class III biological safety cabinets. The use of PG in Class III biological safety cabinets shall require the approval of the Fire Marshal and the Director, Industrial Health and Safety Directorate. Wherever possible, the use of a portable gas canister supply, alcohol lamps, or electric heaters is preferred to the use of the PG system in Class III systems. The PG system shall meet ASA requirements as outlined in the Z-21 series. Where economically feasible, natural gas should be used instead of propane because it is lighter than air and therefore safer to use.

3. Requirements

a. Source: PG shall be supplied by a storage tank system located on a concrete pad outside the building. The construction contractor shall not be required to furnish the propane storage tanks or the valving around the tanks. The tanks will be supplied by the Government and installed and piped by the company supplying the gas.

b. Demand Factor: A demand factor of 10% of total connected load shall be used for design purposes.

c. Distribution: The construction contractor shall be required to run the main PG header through the wall of the building to a point adjacent to the storage tank. A separate main shut-off valve shall be provided on the main supply line immediately after the line enters the building. The valve will be tagged in accordance with 3-07 D.2.

d. Controls: When the use of PG is approved in a Class III system, the supply line shall be equipped with an automatic or spring-loaded "dead-man" shut-off valve.

O. Steam (100-S, 60-S, 10-S)

1. Purpose: The steam system provides steam for the contaminated and non-contaminated areas of the building.

2. Application: Steam is supplied for use in such equipment as cage washers, glassware washers, heating coils, heat exchangers, and sterilizers and for use in the building heating and ventilating system.

3. Requirements

a. Source: The supply to the building shall be from the central steam plant at 100 psig.

b. Distribution: The building main steam header shall be 100 psig. Reduction to 60 or 10 psig on the branch lines shall depend upon the application. Steam traps shall be provided at low points in the steam distribution system and branch runouts and shall discharge to the condensate return line (NHC or NLC). Steam filters or strainers shall be installed prior to steam pressure reducing valves, temperature control valves, and steam seals and prior to the globe valve on lines used for the decontamination or sterilization of process equipment or piping.

Steam lines that tie into the jacket side of process equipment shall go through a steam trap to a flash tank, which shall vent to the atmosphere and discharge to a contaminated sewer line. If it becomes necessary to use the designations Contaminated High Pressure Condensate or Contaminated Low Pressure Condensate (CHC or CLC), such as the drain from steam seals, these services shall drain to the contaminated sewer system.

P. Drinking Water (DW)

1. Purpose: Drinking water (DW) is supplied for use in the contaminated and non-contaminated areas of the building.

2. Application: The DW system shall supply only drinking fountains.

3. Requirements:

a. Source: DW will be supplied by an independent system tapped off the main NCW header entering the building prior to any other tap on this line.

b. Distribution: The DW system shall be copper tubing from the system tap to the drinking fountains.

Q. Distilled Water (DIW)

1. Purpose: Distilled water (DIW) shall be provided for use in the contaminated and non-contaminated areas of the building.

2. Application: DIW may be supplied to laboratory sinks, glassware washing areas, and media preparation areas. Triple-distilled water is not considered a building service and will be produced by and stored in glass equipment where the requirements exists.

3. Requirements:

a. Source: DIW shall be provided by a single distilling system supplied by the NCW system. The still shall be fully automatic, steam heated, and equipped with a storage tank to hold 16 times hourly rate of the still.

b. Location: If possible, the DIW system shall be located to provide gravity flow throughout the building.

c. Limitations: In no case shall the building service steam condensate be utilized for distilled water.

R. Deionized Water (DMW)

1. Purpose: Deionized water (DMW) may be provided as a service to the contaminated and non-contaminated areas of the building. The necessity of supplying DMW as a building service will be determined by the Government.

2. Application: DMW may be supplied to process equipment, laboratory sinks, and media preparation areas.

3. Requirements: The size, type, and location of the deionizer shall depend upon the specific application and shall be supplied by the NCW system.

S. Decontaminant (T)

1. Purpose: Decontaminant (T) may be supplied as a service to the contaminated areas of the building.

2. Application: Piped decontaminant systems are usually limited to use in process areas. For a general discussion of decontamination methods, see Appendix B.

T. Nitrogen (N)

1. Purpose: A single nitrogen system may be provided to serve both contaminated and non-contaminated laboratory areas.

2. Application: Nitrogen is supplied primarily for use in special Class III biological safety cabinet systems where control of the composition of the environment is required (see Plate No. 6.1) and in process operations such as drying and milling.

3. Requirements: The nitrogen system shall be designed to withstand a primary pressure of 150 psig. All valving on the primary side shall be welded or screwed and back-brazed up to but not including the primary side of the pressure regulator. Secondary pressure regulators shall be either pilot or diaphragm operated piston type especially suited for this service.

3-03 PROCESS PIPING

A. General

1. Purpose: Process piping is used for the transfer of agent material and media between process or Class III equipment.

2. Application: The use of process piping is generally limited to process areas and is not found in laboratories.

3. Requirements:

a. Material: Product and slurry lines are constructed of stainless steel tubing. Valving shall be stainless steel body diaphragm valves with high temperature diaphragms.

b. Distribution: Process piping shall be installed for decontamination with 40 psig steam with steam inlets normally at high points in the line and drain at all low points to provide for complete sterilization and drainage. All horizontal runs shall slope in the direction of flow at least ¼ inch per foot. Pocketing shall not be permitted. All process piping shall be gastight by the halogen leak test (see 4-18, EQUIPMENT).

B. Steam Seals

1. All valves that are under a static head of liquid agent such as process or storage vessels shall be the steam washed type of diaphragm valve. On other lines connected to the tank, where isolation from another part of the system is desired, either a steam washed valve or a steam seal shall be used. The steam seal shall consist of two (2) diaphragm shut-off valves in the line with the space between the valves having steam supplied at the high point and containing a condensate drain at the low point (see Plate No. 3.6). In operation, the shut-off valves are closed, the steam is opened wide, and the condensate drain is slightly opened or "cracked" to effect a steam block between the two shut-off valves. The steam, condensate, and air resulting from the steam seal shall be directed to the contaminated waste system.

2. On steam seals used to protect or maintain product integrity, the valving for the steam to the seal shall consist of a reverse globe valve so that steam pressure is on the valve stem packing, followed by a diaphragm valve (see Plate No. 3.6). The drain valve shall also be a diaphragm valve.

3. Steam seals used for safety purposes, such as those on contaminated waste lines where product integrity is not considered, shall be supplied steam by a globe valve that is installed in reversed position to normal flow to place steam pressure on the valve packing at all times. A diaphragm valve will not be required on the steam line. The condensate valve shall be the diaphragm type.

3-04 WASTE PIPING

A. General

1. Three major categories of liquid wastes are handled on the site, storm sewage, sanitary sewage, and contaminated sewage. The storm sewage is used for the conventional rainwater run-off. The sanitary sewage normally handles sanitary sewage from non-contaminated areas of the building and is treated in a conventional sewage treatment plant. The contaminated sewage is collected from the various drains in the contaminated

areas of the building and is treated in a central sterilization plant prior to discharge to the conventional sanitary sewage system.

2. Sewage from a non-contaminated area may be discharged into a contaminated sewage line on the sole basis of engineering considerations of convenience and cost.

3. Toilets, lavatories, floor drains, shower drains, etc., in contaminated change rooms may normally drain to the sanitary sewage system. However, in some specific high risk areas such as pilot plants, etc., floor drains may be required to go to the contaminated sewage system. In the latter case, specific decisions will be made by the Government.

4. Drains from air conditioning units, overflow on distilled water stills, compressor cooling water, etc., shall discharge to the sanitary or storm sewer whenever possible.

5. Laboratory rooms that are intended to be convertible from non-contaminated to contaminated (1-03 L, ARCHITECTURAL) shall drain to the contaminated sewer.

6. Sump pumps in non-contaminated areas should discharge to the sanitary sewer if available, otherwise to the contaminated sewer (never to the storm sewer). Sump pumps in blowcase rooms and other contaminated areas should discharge to the contaminated sewer.

B. Application

1. Special Equipment: There shall be drains from the following special equipment: Class I biological safety cabinets, Class III biological safety cabinets, chemical fume hoods, cage service cabinets, and others as required.

2. Manifolding: Biological safety cabinets that are joined together and are not separated by air locks or doors may have a common manifolded drain system with a single drain valve and trap on the manifold. Individually segregated sections of a cabinet array shall contain separate drains, valves, and traps.

3. Radiological Laboratories: Drains from sinks, radiological fume hoods and any other equipment in rooms that handle radioactive isotopes shall be disconnected from the waste drain system to prevent any discharge of waste, except for sterilizers, which shall discharge to the contaminated waste system. Liquid wastes produced in these rooms shall be collected in containers for disposal in accordance with the Fort Detrick Radiological Safety Manual, Dec 63. Approval for any open drains in such rooms must be given by the Chief, Industrial Health and Safety Office.

4. Walk-In Refrigerators and Incubators: All walk-in refrigerators and walk-in incubators shall be provided with one (1) floor drain located as near to the back as possible.

5. Rooms and Corridors: All rooms and corridors, including attic and basement, shall be provided with one or more floor drains located as near the center of the room as possible. These drains shall be arranged so that they may be used as drains or, if so desired, a screw-type plug may be inserted, thereby sealing the drain.

6. Non-Contaminated Offices: Non-contaminated offices and corridors shall in general not be provided with floor drains unless there is a possibility of future conversion to laboratory use (see 3-04 A.5). Where drains are installed in these rooms, they shall be plugged.

7. Plenum Chambers

a. Air Supply Plenum: A metal pan may be substituted for the concrete floor of the air supply plenum after the entry louvers and the preheat coils. The plenum shall be equipped with a drain. This drain and the cooling coil drain shall be discharged to the storm water drain or carried outside the building and discharged.

b. Air Exhaust Plenum: A metal pan may be substituted for the concrete floor of the exhaust plenum, between the main air exhaust duct connection and the deep bed filters. The plenum shall be equipped with a drain, trap, and diaphragm valve. The trap shall be deep enough to prevent negative pressure of the plenum from pulling the trap. The drain line shall be connected to the contaminated sewage system and shall have the diaphragm valve installed in the horizontal section of the line after the trap.

8. Equipment Rooms: In equipment rooms, glassware washing rooms, and cage washing rooms, additional floor drains shall be installed as necessary to service all drain lines, blow-down systems, overflows, etc., that are an integral part of the piping for such equipment. These drains shall be in addition to the general floor drains in equipment rooms.

9. Air Locks: Air locks shall have no floor drains; however, the floor shall slope toward the more contaminated room or corridor for drainage purposes.

C. Separation of Drains

1. Closed and Open Equipment: Drains from each piece of closed equipment such as Class III biological safety cabinets shall drain directly to the main contaminated waste header outside the building through a separate header intended only for this purpose. They shall not tie into drain lines from open equipment such as sinks and floor drains.

2. Between Floors: Cross connection of contaminated plumbing lines between attic, upper, first, or basement floors shall not be allowed. Drains on each floor of a contaminated building shall be manifolded together. The resultant drain headers shall drain (separately) to the contaminated sewer line, outside the building.

D. Floor Drain Details

1. Sizing: Floor drains shall be 4 inches in diameter.

2. Type of Drain: Floor drains, in general, shall be non-clog bucket-type drains (Josam 300-35C series or approved equal) and be equipped with 10-inch catch pan and adjustable strainer height.

3. Automatic Trap Priming: Automatic trap priming shall be provided to all floor drains to insure that they will remain sealed.

4. Threaded Plugs: Floor drains shall be supplied with screw type plugs which may be inserted if the drain is not required.

5. Animal Rooms: Floor drains in animal rooms shall be non-clog bucket-type drains (Josam 3740 series or approved equal) and be equipped with 10-inch catch pan and adjustable strainer height.

6. Trenches: Floor trenches shall not be used in such a way as to permit open flow of contaminated liquid waste.

E. Drain Line Details

1. Guide Specification: See Appendix C, services CCD, NCD, CV, and NCV.

2. Buried Lines

a. Minimum Size: All drain lines beneath floor slabs on grade shall be not less than 4 inches in diameter.

b. Covering: For protection and identification purposes, all underground contaminated sewage lines, except lines under buildings, shall be placed in a trench and covered all around with a minimum of 6 inches of concrete measured from the surface of the pipe.

c. Type of Pipe: Buried drain lines shall be extra heavy cast iron soil pipe, bell and spigot joint, and lead sealed.

3. Lines from Closed Equipment: All drains from equipment closed to the room such as biological safety cabinets, Class III, shall be Schedule 40, welded, wrought iron pipe.

4. Lines from Open Equipment: All drains from sinks, sterilizers, and chemical fume hoods open to the room (except floor drains) shall be screwed fittings to a point immediately after the trap; thereafter, the lines shall be Schedule 40 welded wrought iron pipe.

5. Floor Drain Lines: Floor drain traps and drain lines shall be Schedule 40, welded, wrought iron pipe when exposed.

6. Vent Lines to Drains: All vent lines from sinks, sterilizers, floor drains, etc., shall be Schedule 40, welded, wrought iron pipe.

F. Vents

1. General: The infectious hazard associated with various contaminated waste lines varies widely, depending upon the source of the waste, its previous treatment, and the amount handled. Repeated testing has established that the majority of contaminated waste lines may be safely vented directly to the atmosphere without filtration. Vents from waste lines carrying highly toxic or infectious materials such as from fermentors and waste collection treatment tanks must be routed to incinerators. Where questions of vent routing arise, the final decision will be made by the Government.

2. Cross Connections: There shall be no cross connection of vent lines from different floors. Each floor shall be vented separately. Vents from the same floor shall be tied together in the attic, then run through the roof as a single vent, with filter adapter, shut-off valves, and steam connection to the pipe line filter.

3. Special Tests: Upon completion of all vent piping systems, a separate smoke test shall be made of both contaminated and non-contaminated vent systems to insure against cross connections in these systems. This test shall be performed by the contractor in the presence of the contracting officer or his representative.

4. Contaminated Vent to Incinerator

a. Applications: See 2-08 A, HV&AC.

b. Pipe: Pipe shall be carbon steel conforming to ASTM A-53. Pipe shall be Schedule 40 for sizes six (6) inches and below; Schedule 20 for sizes eight (8) inches to twelve (12) inches inclusive; and Schedule 10 for sizes fourteen (14) inches and larger.

c. Fittings: Unless otherwise indicated, fittings shall be butt-welded type. Elbows shall be long radius type with minimum 1½ radius bend. Standard weld reducers shall be used for pipe sizes up through six (6) inches. The included angle of reduction between opposite walls of the notched pipe shall not exceed 30 degrees. Ells eight (8) inches and larger may be five-piece miter with minimum 1½ radius bend.

d. Valves: Valves shall be diaphragm type with cast steel body and high temperature diaphragm.

e. Branch Connections: All connections of branches to mains shall be made at a 45-degree angle for streamline flow. Connections of risers into the main shall be made by looping the branch into the top of the main.

f. Seals Around Penetrations: For seals around pipes passing through walls and floors see 1-05 E, ARCHITECTURAL.

g. Pipe Line Filters: Pipe line filters shall be required in all contaminated vent line headers between last connection and atmosphere, except those from Class III safety cabinets where the individual cabinet or cabinet system is provided with an individual HEPA exhaust filter (see 2-06 D.6, HV&AC). Pipe line filters shall be high-efficiency type (see 2-09 C). (See Plate No. 3.4.)

G. Valves

Diaphragm valves shall be used in contaminated drain and vent lines. Installation of diaphragm valves shall be as in 3-02 A.2.b. In cases where a heavy load of solids may be expected, such as in animal rooms, the straight-through type of diaphragm valve may be used.

H. Sterilizers

1. Equipment: See 4-06 EQUIPMENT, for details on sterilizers.

2. Drainage: Waste lines from sterilizers shall discharge into a contaminated sewage line, which shall be a branch line from a main serving other similar drains. Screwed connections shall be used up to and including the union after the steam trap. After the union, the lines shall be welded. (See Plate No. 3.4 for schematic of waste piping.)

3. Venting: All sterilizers (including rupture discs and safety valves) directly connected to equipment such as biological safety cabinets, aerosol chambers, etc. must be vented in a manner identical to the equipment to which they are connected as far as filtration and incineration are concerned, except that the sterilizer exhaust will not be filtered before tying into the manifold or main vent header. The vent line for the sterilizer drain shall be tied into the drain line before the trap (see Plate No. 3.4). The drain line after the trap can be vented through a regular plumbing vent. Vents on sterilizers shall be of sufficient size so that upon exhaust, the trap in the drain line will not be blown.

a. Sterilizers Attached to Class III Safety Cabinets: Biological safety cabinet, Class III, sterilizer vents and safety valve discharge shall discharge by separate lines to the main CVI header, which in turn discharges to a central incinerator. Vent lines

shall be properly sloped for drainage. These lines shall not tie into the exhaust line from the biological safety cabinet. If a building does not have a vent system connecting to a central incinerator, the vent from the sterilizer shall tie into the exhaust from the biological safety cabinets in the building attic between the cabinet outlet bacterial filter and the electric air sterilizer (see Plate No. 3.4).

b. Other Sterilizers: The vent from other sterilizers in contaminated areas not connected to Class III safety cabinets and not free standing, i.e., those connecting two rooms or those connected to Class I safety cabinets, shall be carried individually to the attic where they shall top-connect to a manifold or main vent header. This manifold shall exhaust into the building exhaust filter chamber after the pre-filters, if any, and ahead of the deep bed filters (see Plate No. 3.4). The manifold shall be sized so that its pressure will not differ appreciably from that in the building exhaust filter chamber, and shall be equipped with a trap to keep moisture out of the building exhaust system. Vents from free standing sterilizers shall discharge directly to the atmosphere through the roof.

I. Waste Collection Treatment Units

1. General Criteria

All liquid waste leaving an infectious disease laboratory or process building must be sterilized by the Post Sewage Sterilization Plant. In addition, when large amounts of infectious material as from large fermentors, holding tanks, and aerosol chambers are to be disposed of, a waste collection treatment unit shall be interposed so as to "pasteurize" (reduce the number of viable organisms) or to sterilize the waste before discharge to the Post Sewage Sterilization system.

A local waste collection treatment system is not needed in a building in which the largest unit container is five (5) gallons. In these buildings waste can be discharged directly to the Post Sewage Sterilization system.

Determination for the requirement of a separate waste collection treatment unit shall be made by the Government prior to the preliminary design phase. The contaminated sewage system includes a special central sterilization plant to render agent material sterile prior to discharge into the conventional sanitary sewage plant.

When treatment of liquid effluents is required, a waste collection treatment unit shall be designed in accordance with either 2.a, 2.b, or 2.c below. The type of treatment unit shall be specified by the Government.

When pasteurization is allowed, waste collection treatment units shall be designed for continuous operation at 200°F with a retention time of at least one minute; however, provision shall be made for future use of units for batch sterilization.

2. Method of Operation

a. Batch Sterilization Type: Plate 3.7 is a diagram of a batch sterilization installation. Operation is manual (for controls, see 6-02 C, INSTRUMENTATION). Liquid waste is heated by injection of live steam at 40 psig and held at temperature (287 F) for a given period. The spargers shall be constructed of corrosion-resistant material capable of withstanding steam and decontaminants (see Appendix B). The vessel may then be cooled by a water spray before release of pressure and discharge of treated waste to the contaminated sewer line. The use of the cooling spray is optional.

b. Pasteurization Type: Plate 3.8 is a diagram of a continuous, high-temperature pasteurization installation. Operation is automatic (for controls, see 6-02 C, INSTRUMENTATION). Waste is maintained at 200 F by injection of live steam. The waste discharges continuously, by gravity, through a retention tube immersed in the bulk liquid. The tube is provided to avoid the danger of short circuiting, and is designed for a minimum residence time of 1 minute.

c. Continuous-Flow, Heat-Exchanger Sterilization System: Plate 3.9 is a schematic sketch of a continuous-flow, heat-exchanger sewage sterilization system. This system is preferred for sterilizing large volumes of liquids, as from several laboratory buildings. However, the heat-exchanger sterilization system is flexible and, because this system has a number of distinct advantages over the tank sterilization systems, it may be the system of choice even when volume flows are quite small. The procurement and installation costs of the heat-exchanger system are relatively high, but operating costs are very low. The heat-exchanger system is ideally suited to short-term heat treatment of a liquid. The contaminated, low-temperature sewage picks up heat from the high-temperature sterile sewage so that only relatively small amounts of heat need be added to bring the system to operating temperatures. The sterile sewage is cooled to a point where it can be readily discharged from the system. Liquids from the laboratory areas are drained by gravity into a holding tank. A comminutor may be placed in the drain line before the line empties into the holding tank or tanks. Steam will be added through the steam injector to preheat the system. When full operating temperatures have been reached, sewage flow will be started (at a low flow rate to prevent steam collapse in the shell) through the system by operating the circulating pump. A second pump located after the retention tubes but before the second pass through the heat exchangers is essential. This second pump raises the pressure of the treated sewage so that if there is a leak between the tube and shell side of the heat exchanger it will be sterile sewage into contaminated sewage, not contaminated sewage into treated sewage. A rubber diaphragm type of sampling adapter should be placed on the discharge line and samples taken at intervals to check on the sterility of the treated sewage.

The temperatures desired throughout the system as well as the retention time and per cent of heat recovery can be varied by the design and materials of the system.

3. Capacity

a. Batch Sterilization Type: The vessel shall be of sufficient volume to hold the liquid waste from all the connected equipment for a twelve (12) hour period. One basis for sizing of minimum capacity is: total working capacity of all chambers and safety cabinets plus 25% of this capacity to take care of condensed steam and other waste.

b. Pasteurization and Heat Exchanger Types: The capacity of the holding vessel can be the same as above for batch operation except the time period should be eight (8) hours.

c. Two Holding Vessels: When an individual building treatment system is of the batch type, two (2) holding vessels shall be used.

4. Design Criteria

a. General: A primary and most important component of waste collection treatment units is the location and consistency of valves and equipment so as to facilitate operation, maintenance, and safety. In the primary design of the system, important items of maintenance and safety should be considered to keep downtime at a minimum, with performance and safety at a maximum. Easy access to replacement parts such as valves, diaphragms, and long probes is essential.

b. Location: Waste collection treatment units shall be located in rooms separated from the operating equipment that they service (see also 1-01 C.3, ARCHITECTURAL).

c. Water-Tight Pit: Waste collection treatment units shall be installed in a water-tight concrete pit large enough to hold the contents of the blowcase if the pit drains are blocked in conjunction with rupture of the blowcase.

d. Anchors: Waste collection and treatment tanks shall be securely anchored to prevent floating in the event that pit drains become blocked and the pit fills with water.

e. Treatment Tank: Treatment tank shall be designed for operating pressure and full vacuum and meet the requirements of the lethal vessel section of the ASME unfired pressure vessel code.

f. Retention Tube: Retention tubes should be located inside the waste collection treatment unit and shall be constructed of corrosion resistant material capable of withstanding steam and decontaminants (see Appendix B).

g. Sealing and Leak Testing: Where possible, all joints shall be of welded construction. Where it is necessary to use flange and gasket joints such as on pumps, ejectors, and heat exchangers, a halogen leak test (see 4-18, EQUIPMENT) of the waste collection treatment system shall indicate no leakage at maximum operating pressures. If the system is insulated, access shall be provided to all valves and flanges to permit future halogen leak testing.

h. Wall Finish: The interior surfaces of rooms in which waste collection treatment units are located shall be resistant to high humidity, high temperature, and decontaminating agents. See Section 1-05 B, ARCHITECTURAL for details on wall finishes.

i. Ventilation: Waste collection treatment unit rooms shall be ventilated. See 2-05 E, HV&AC for details.

j. External Controls: When specified by the Government, provision shall be made for operating control system external to the waste collection treatment unit enclosure or room.

5. Venting (CVI)

a. Vent lines from waste collection treatment units shall discharge into a separator or condenser that discharges through a vent header into an incinerator.

b. See 3-04 F.4 for details on CVI vent system.

6. Drainage

a. Inlet Lines

(1) Lines to waste collection treatment units shall be Schedule 40, welded wrought iron lines. Diaphragm valves (see 3-04 G) shall be used in such lines.

(2) The waste collection system should be designed to operate by gravity flow to the collection tank by sloping the pipe a minimum of ½ inch per foot in the direction of flow.

(3) Highly contaminated, all welded lines running to waste collection treatment units shall be suitably marked for easy identification. All lines shall be marked according to color code (see 3-07) with paints or markings resistant to all decontaminants.

b. Drain Lines

(1) Drain lines from waste collection treatment units shall have a diaphragm valve (see 3-04 G) and shall not be connected to any other lines inside the building except lines from other waste collection treatment units.

(2) Drain lines from waste collection treatment units shall discharge directly to main contaminated drain line headers outside the building.

c. Room Drain: Waste collection treatment unit rooms shall have natural drainage to the contaminated sewer system; otherwise they shall drain to an open sump with both a sump pump and steam jet ejector for discharge to the contaminated sewer system.

7. Controls

For information on the instrumentation and controls for waste collection treatment units, see 6-02 C, INSTRUMENTATION.

3-05 FIRE SPRINKLERS

A. Criteria for Use

1. New Buildings: Although this manual prescribes minimum use of wood and other combustible materials of construction, it does not call for fireproof construction (see 1-04 D, ARCHITECTURAL). Therefore a water sprinkler system is to be installed in all new buildings, subject to approval by the Government.

2. Conversions: In altering contaminated laboratories, sprinkler systems shall be provided where none exist.

B. Technical Features

1. Fire protection sprinkler systems shall be designed in accordance with National Fire Protection Association Pamphlet No. 13, "Standards for Installation of Sprinkler Systems" (also issued as NBFU 13).

2. To provide maximum available pressure, water used for fire sprinkler systems shall be tapped off the street main and run to the building as a separate supply.

3. The selection of fog nozzles shall be made with proper consideration given to such factors as physical character of the hazard involved, draft or wind conditions, material likely to be burning, and the general purpose of the system. Because of biological hazards, fog nozzles shall be provided.

C. Fire Hose Access: A penetration shall be provided in at least one exterior wall of the contaminated area for a fire hose access port. This opening shall be a capped pipe sleeve installed in the wall, which may be opened to allow firemen to pass a fire hose directly into the contaminated area of the building without having to traverse the change room labyrinths.

D. Sprinkler Alarm System

1. Central Alarm: Operation of any part of the sprinkler system shall activate an alarm in the central firehouse.

2. Branch Alarms: Branch alarms shall be installed in each main corridor and wing of each building, activated by flow in branches of the sprinkler header system.

3. Fire Detection and Alarm System

a. Conversions: In buildings erected previously without a sprinkler system (see 3-05 A above), a fire detection and alarm system was provided. If sprinkler systems are installed during the alteration of such buildings, the Government will determine the disposition of the existing fire detection and alarm systems.

b. New Buildings: A separate fire detection and alarm system shall not be provided in new buildings unless specifically called for by the Government.

c. Reference: See 5-08, ELECTRICAL, for criteria for the fire detection and alarm system.

E. Flammable Material Storage: See Section 1-03 J, ARCHITECTURAL.

3-06 INSULATION

A. General

1. All insulation that is subject to mechanical abuse shall be adequately protected.

2. See 2-10 E, HV&AC for insulation requirements for HV&AC equipment and ducts.

3. Standard commercial insulation and practices shall be used in the non-contaminated areas.

4. For both contaminated and non-contaminated areas, all insulation materials shall have a surface flame spread rating not higher than 25 without evidence of continued progressive combustion, and shall be of such composition that surfaces exposed by cutting through the material in any way shall have a flame spread rating not higher than 25 without evidence of continued progressive combustion. Smoke generation rating shall not exceed 50. (Flame spread and smoke generation ratings as used herein refer to ratings obtained according to the "Standard Test Method for Fire Hazard Classification of Building Materials," ASTM E84 NFPA No. 255, UL Standard.) These limitations shall not apply on piping or equipment when the insulation materials are sheathed in stainless steel.

B. Special Criteria for Contaminated Areas

1. Piping should be routed, and equipment located, so as to minimize the use of insulation with due regard for cost and functional requirements.

2. Where burn protection only is needed, the possibility of using fenders instead of insulation should be considered. For hot water, steam, and condensate piping, full-length burn protection shall be provided in pipe chases.

3. Insulation shall be finished with materials that will withstand the decontamination procedures for the given area, and will retain a firm, smooth, crack-free outer surface impermeable to moisture.

4. Insulation shall be fabricated of non-organic materials and shall be of a type to prevent biological migration (closed-cell, reflective, etc.). In the event of damage to the finish material, the insulation shall not deteriorate when directly exposed to decontamination procedure. If insulation is metal sheathed, both of these requirements may be waived.

5. Insulation for process piping (rarely used), or for any other line to be halogen leak tested, shall be applied after testing and shall not cover potential pipe leak spots such as screwed fittings.

6. Insulation used in any room in which equipment must undergo halogen leak testing shall be fabricated of non-halogen liberating material (see 4-19, EQUIPMENT). Where insulation is enclosed in a gas-tight sheath preventing escape of halogens, or is for refrigerators (see 4-03 C.3, EQUIPMENT), this requirement may be waived.

7. Equipment or piping potentially subject to leaks shall have an insulation system unaffected by the leaking material. (For example, polystyrene shall not be used over equipment or piping handling trichlorethylene.)

8. Seals around insulated lines passing through walls separating areas of different levels of contamination and through floors or ceilings in contaminated areas shall be provided in accordance with sub-section 1-05 E, ARCHITECTURAL (Plates No. 1.15, 1.19, and 1.20).

3-07 MARKING AND COLOR CODE

A. Pipe Line Symbols and Color Code: Table 3.1 lists the symbols and color code for the various piping services, including process and waste.

B. Standard Military Code: The standard military color code shall be used as specified in MIL-STD-101A 5 March 1954, "Color Code for Pipelines and Compressed Gas Cylinders," and AR 385-30, 16 August 1965, "Safety - Safety Color Code Markings and Signs" (Cylinders and Pipe

Lines). This includes colors, stenciling of panels, and metal tagging of valves. Terminal cocks shall be marked by stencil or names on stop cock handle; lines shall be stenciled at the point of entrance into a room, and at least once every fifteen (15) feet in continuous span and at turns and junctions (see Plate No. 3.10).

1. The use of decals or tape, instead of paint, is approved provided that appropriate colors are used and that the decals or tape are compatible with the decontaminating agents used in the contaminated portions of the building.

2. Luminous paints should be considered for color coding lines and marking valves in attics, for improved visibility.

C. Biological Hazard Warning Symbol: A universal, USPHS approved biological hazard warning symbol shall be used to identify areas such as entrances to certain laboratories and animal rooms and equipment such as refrigerators, incubators, and deep freezers used with infectious materials.

1. Scope: The biological hazard warning symbol (biohazard symbol) specified herein shall be used to signify the actual or potential presence of a biohazard and to identify equipment, containers, rooms, materials, experimental animals, or combinations thereof that contain or are contaminated with viable hazardous agents.

For the purpose of this standard, the term "biological hazard" or, synonymously, biohazard, shall include only those infectious agents presenting a risk or potential risk to the well-being of man, either directly through his infection or indirectly through disruption of his environment.

The standard does not specify a minimum hazard level for which the symbol shall be used.

2. Symbol: The biohazard symbol for signifying biological hazard as defined in the scope of this standard shall be designed and proportioned as illustrated on Plate No. 3.11.

The symbol shall be as prominent as practical and of a size consistent with the size of the equipment or material to which it is affixed, provided that the proportions shown are maintained, and, in any case, that the symbol can be easily seen from as many directions as possible.

Except when circumstances do not permit, the symbol shall be oriented with one of the three open circles pointed up and the other two forming a base.

3. Color: The symbol design shall be a fluorescent orange or orange-red.* Background color is optional as long as there is sufficient contrast for the symbol to be clearly defined.

4. Restrictions: The biohazard symbol shall be used or displayed only to signify the actual or potential presence of biological hazard as provided in the scope of this standard.

Appropriate wording may be used in association with the symbol to indicate the nature or identity of the hazard, name of individual responsible for its control, precautionary information, etc., but never should this information be superimposed on the symbol.

*Day-Glo® Fire Orange of the Switzer Brothers, Inc., is cited as an example, not an endorsement.

D. Metal Tagging of Valves: All valves on all lines shall be tagged as follows:

1. Contaminated Service and Process Lines: All valves on contaminated service and process lines shall be tagged with a star-shaped tag, wired to the valve. Tags shall be of enameled steel, brown, and with the line symbol stamped thereon (i.e., CCD, etc.).

2. Non-Contaminated Service Lines: All valves on non-contaminated service lines shall be tagged with a round tag, wired to the valve. Tags shall be of plain aluminum and uncolored with the line symbol stamped thereon (i.e. DW, etc.).

E. Marking Lines Entering or Leaving a Building

A metal plate shall be attached to the outside wall of a building immediately above the point where a line enters or leaves the building. This plate will give the type of service, the size of the line, and the depth of the line.

TABLE 3.1

Marking and Color Code (3-07 A)

Symbol	Basic Band Color	Secondary Arrow Color	Service
100-S	Gray	Gray	Steam - 100 psig
60-S	Gray	Gray	Steam - 60 psig
10-S	Gray	Gray	Steam - 10 psig
NHC	Gray	White	High Pressure Condensate 60 psig and Above, Non-Contaminated
CHC	Gray	Brown	High Pressure Condensate, Contaminated
NLC	Gray	White	Low Pressure Condensate Below 60 psig, Non-Contaminated
CLC	Gray	Brown	Low Pressure Condensate, Contaminated
DW	White	White	Drinking Water
NCW	White	White	Cold Water, Non-Contaminated
CCW	Brown	Brown	Cold Water, Contaminated
NHW	White	White	Hot Water, Non-Contaminated
NHW-R	White	White	Hot Water Return - Non-Contaminated
CHW	Brown	Brown	Hot Water, Contaminated
CHW-R	Brown	Brown	Hot Water Return, Contaminated
ACW	White	White	Air Conditioning Water
ACW-R	White	White	Air Conditioning Water Return
DIW	White	White	Distilled Water
DMW	White	White	Deionized Water
N	Gray	Black	Nitrogen
HDC	Black	Black	Hydraulic Lines
CA (Old Symbol, CPA, NPA)	Gray	Green	Compressed Air
DCA	Gray	Green	Dry Compressed Air
IA	Gray	Green	Instrument Air
MA	Gray	Green	Mask Air
PG (Old Symbol, CPG, NPG)	Yellow	Yellow	Propane Gas (formerly Pyrofax Gas)
NVA	Gray	Gray	Vacuum, Non-Contaminated
CVA	Brown	Gray	Vacuum, Contaminated
CCD (a)	Brown	Brown	Drain, Contaminated
NCD (b)	No Color	No Color	Drain, Non-Contaminated
NV	Gray	Gray	Vent, Non-Contaminated
CV (c)	Brown	Brown	Vent, Contaminated

TABLE 3.1 - Continued

Symbol	Basic Band Color	Secondary Arrow Color	Service
CVI	Brown	Brown	Vent, Contaminated to Incinerator
T	Gray	Gray	Decontaminant Lines
FRE	Gray	Gray	Freon
BC	6" Brown Band - BC Stenciled in Black on Band	Orange	Blowcase Line (Waste Collection Treatment)
SW	White	White	Storm Water
CULT (c)	Blue	Gray	Product
MED	Pink	Pink	Slurry
GLUC	Black	Black	Glucose Solution
HYD	Tan	Tan	Hydrolysate
PRA	Gray	Brown	Process Air
DPRA	Gray	Brown	Dry Process Air
ACID	Blue	Blue	Acid
ALK	Blue	Blue	Alkali
CWS	White	White	Tower Water Supply
CWR	White	White	Tower Water Return
CWS-60 (d)	Brown	Brown	60° Cooling Water Supply (d)
CWR-60 (d)	Brown	Brown	60° Cooling Water Return (d)
RCWS-35 (d)	Brown	Brown	35° Refrigerated Water Supply (d)
RCWR-35 (d)	Brown	Brown	35° Refrigerated Water Return (d)
TWS-H	Brown	Brown	Tempered Water Supply, Hot
TWS-C	Brown	Brown	Tempered Water Supply, Cold
TWR	Brown	Brown	Tempered Water Return
HWS	White	White	Heating Water Supply
HWR	White	White	Heating Water Return

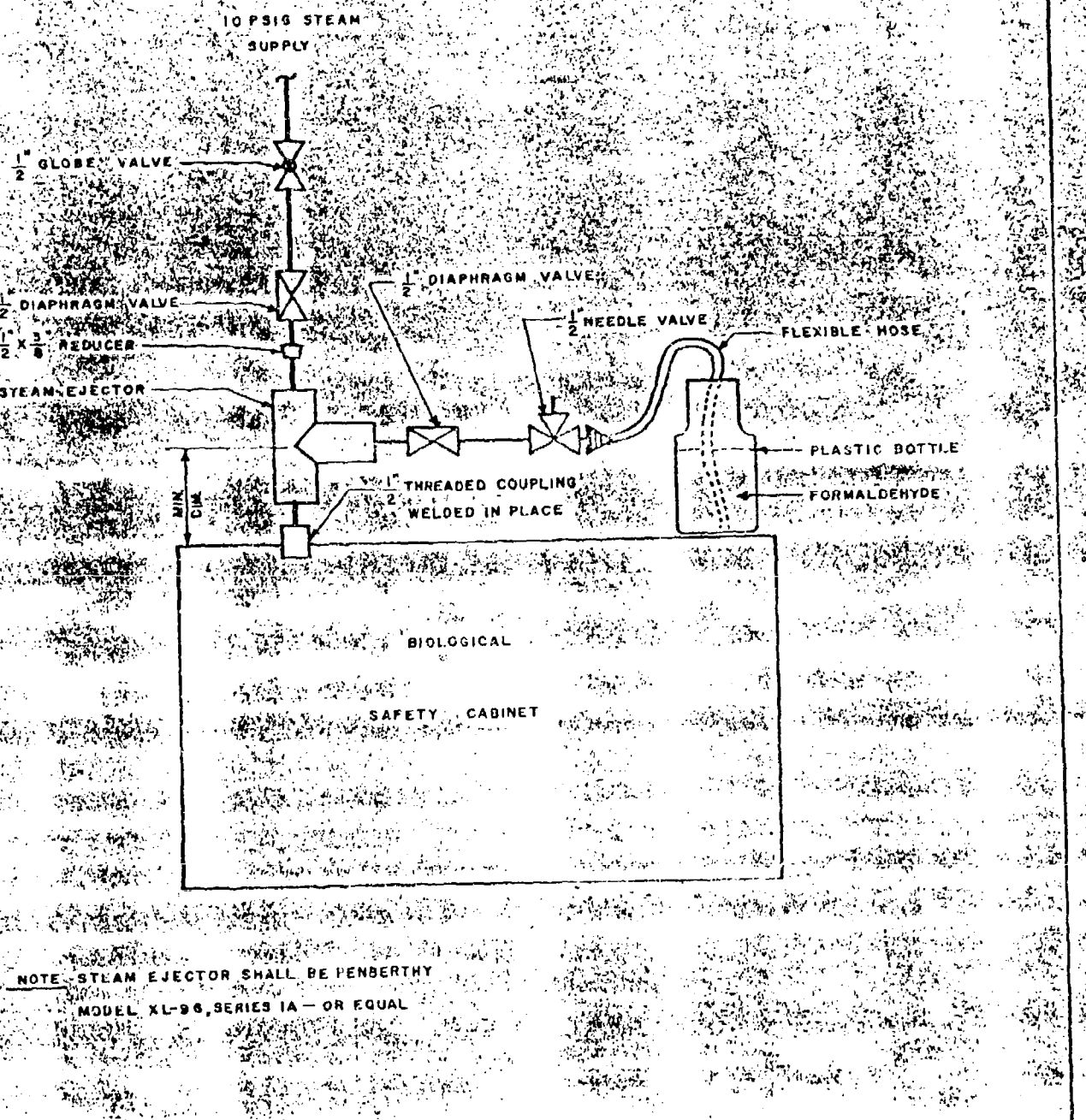
Note: 1. On insulated lines, code is to be applied on insulated portion.
2. If pipe or covering is same color as basic band color, then band is not required and arrow should be of contrasting color.

(a) When used in process area, secondary arrow color is gray, and symbol is placed on 4-inch orange band.

(b) When used in process building, colors are black and black.

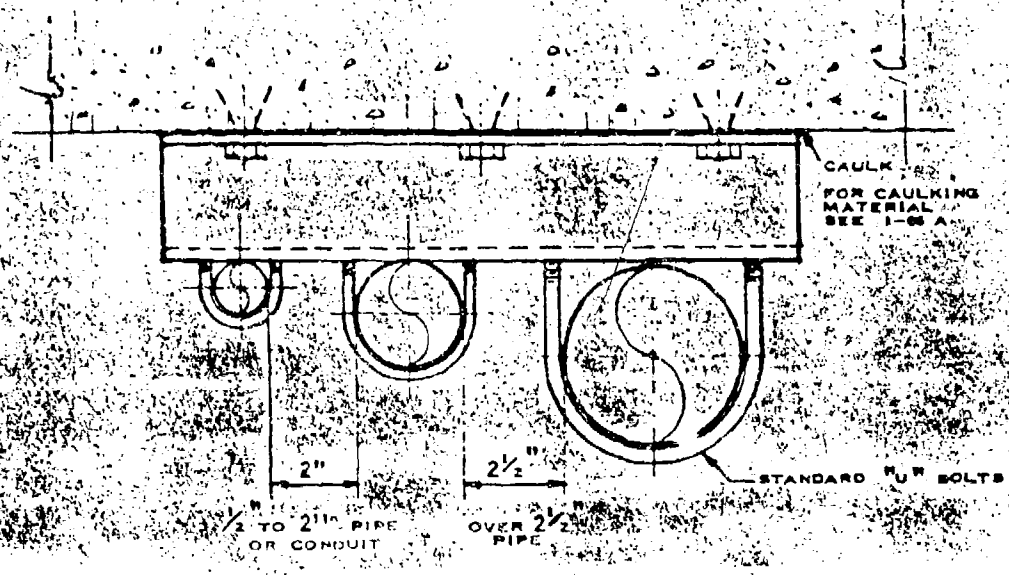
(c) When used in process area, symbol is placed on 4-inch orange band.

(d) Other temperatures may be specified.

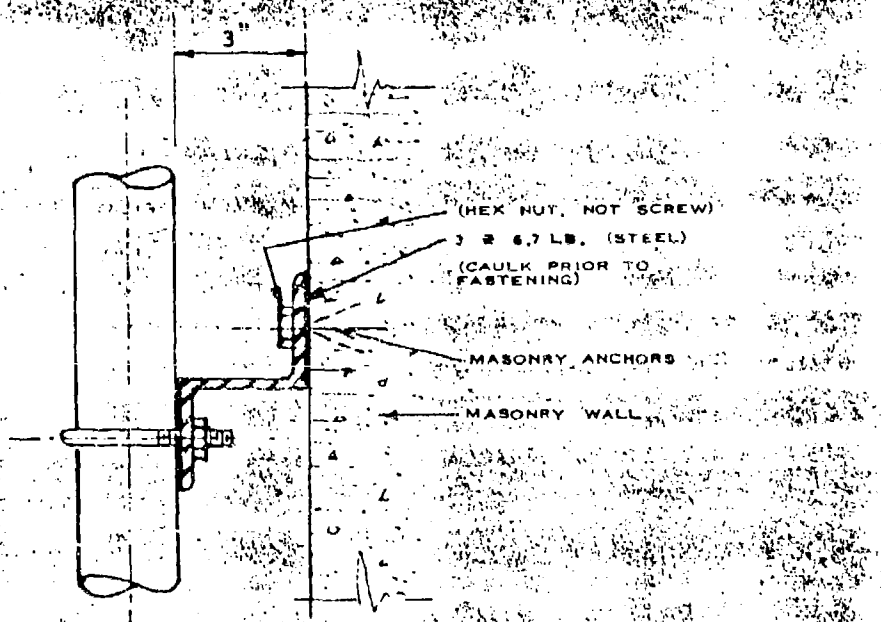


NOTE - STEAM EJECTOR SHALL BE PENBERTHY MODEL XL-96, SERIES 1A — OR EQUAL

SERVICE PIPING FOR STERILIZATION OF CABINETS WITH STEAM—FORMALDEHYDE	⚠1	6/67	GENERAL REVISION
	REV.	DATE	DESCRIPTION
	DATE-1 FEB. 66		PLATE NO. 3.1



PLAN



SECTION

TYPICAL PIPE AND CONDUIT WALL SUPPORT DETAIL	REV.	DATE	DESCRIPTION
	DATE - 1 FEB. 66		PLATE NO. 3.2

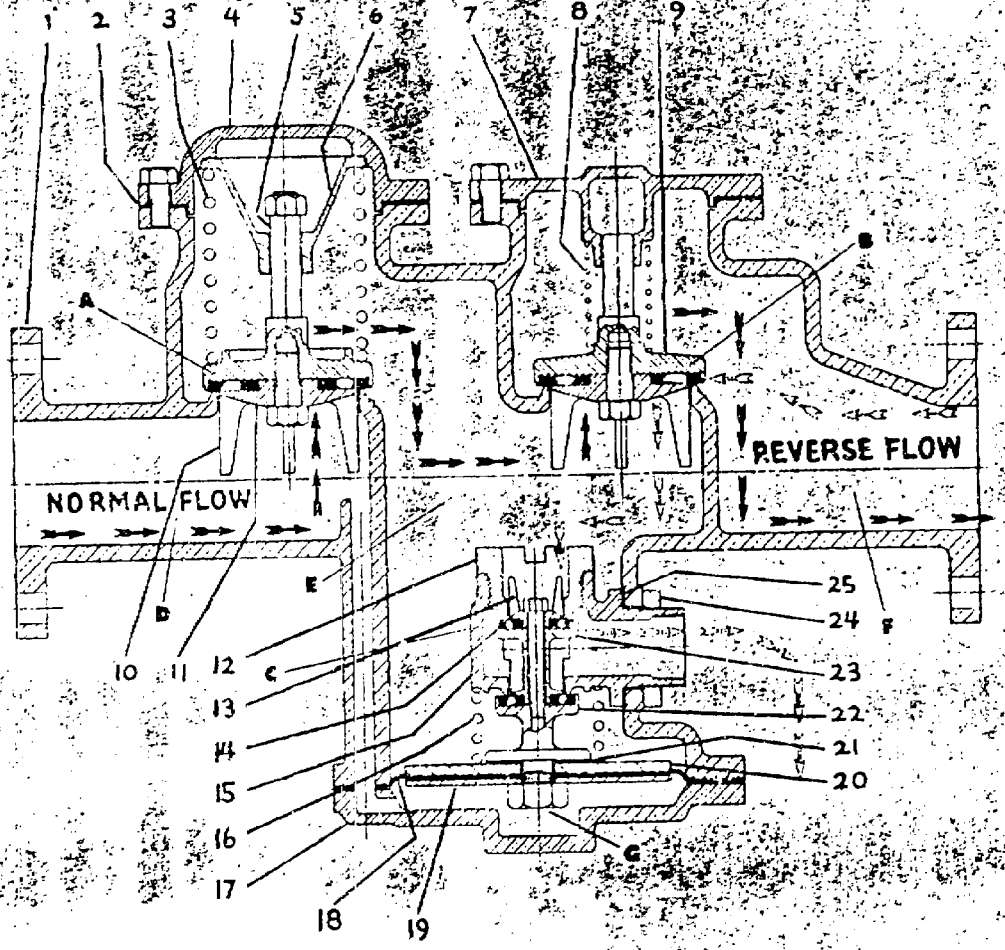
3/68

3/68

REDUCED PRESSURE BACKFLOW PREVENTER

PARTS LIST FOR 3" SIZE
OTHER SIZES VARY SLIGHTLY

1 Body
2 Cover Plate Gasket
3 Main Valve Spring
4 Main Valve Cover
5 Main Valve Disc Holder
6 Main Valve Spring Retainer
7 Check Valve Cover
8 Check Valve Spring
9 Check Valve Disc Holder
10 Main & Check Valve Guide
11 Main & Check Valve Disc
12 Relief Valve Seat
13 Relief Valve Guide
14 Upper & Lower Relief Valve Disc
15 Relief Valve Housing
16 Relief Valve Spring
17 Relief Valve Cover Plate
18 Diaphragm
19 Lower Diaphragm Plate
20 Upper Diaphragm Plate
21 Clamp Bolt Gasket
22 Relief Valve Clamp Bolt
23 Relief Valve Spacer
24 Relief Valve Lock Nut
25 Relief Valve Housing Gasket

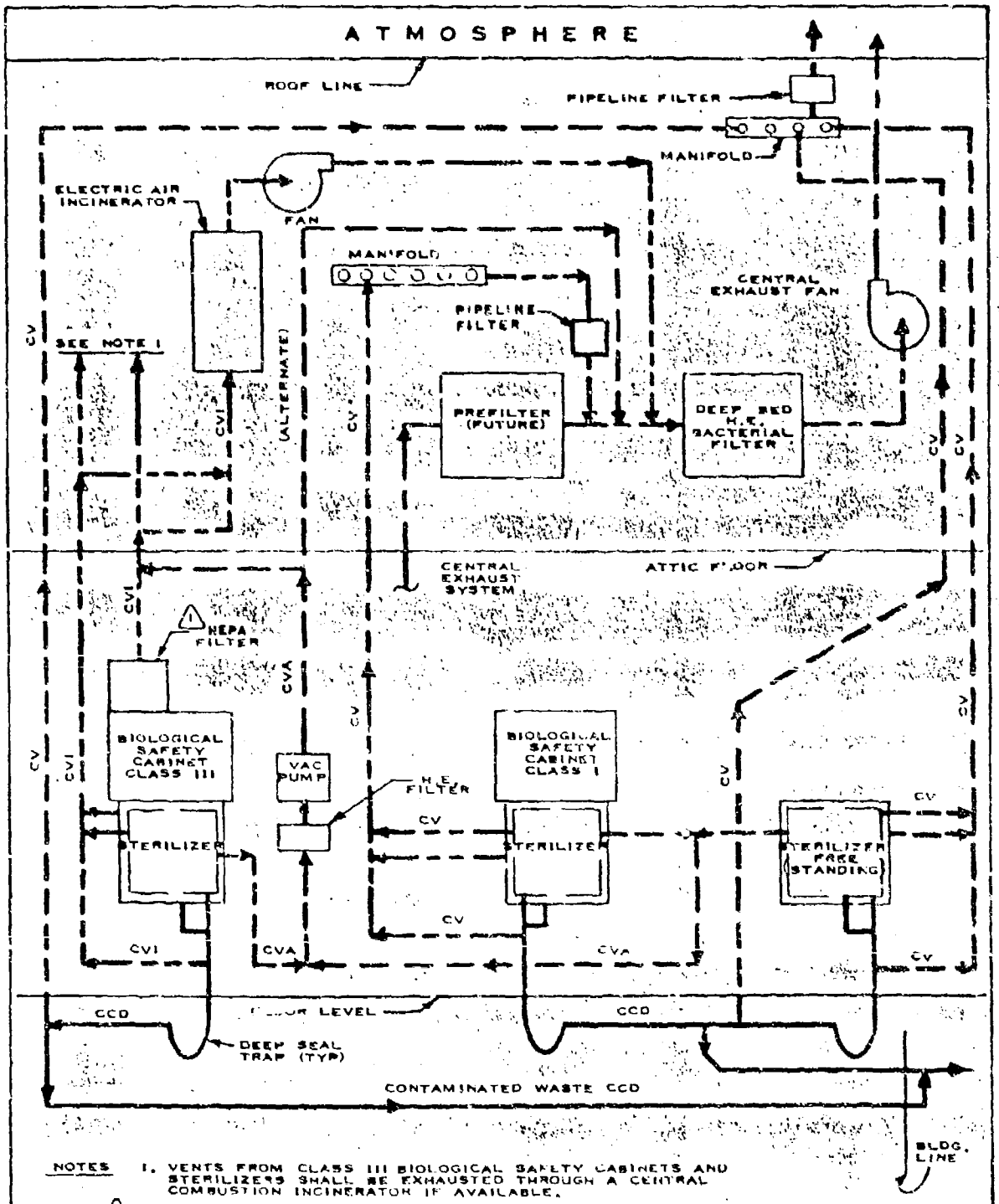


REV.	DATE	DESCRIPTION

DATE - 1 JULY 67

PLATE NO. 3.13

3.13A



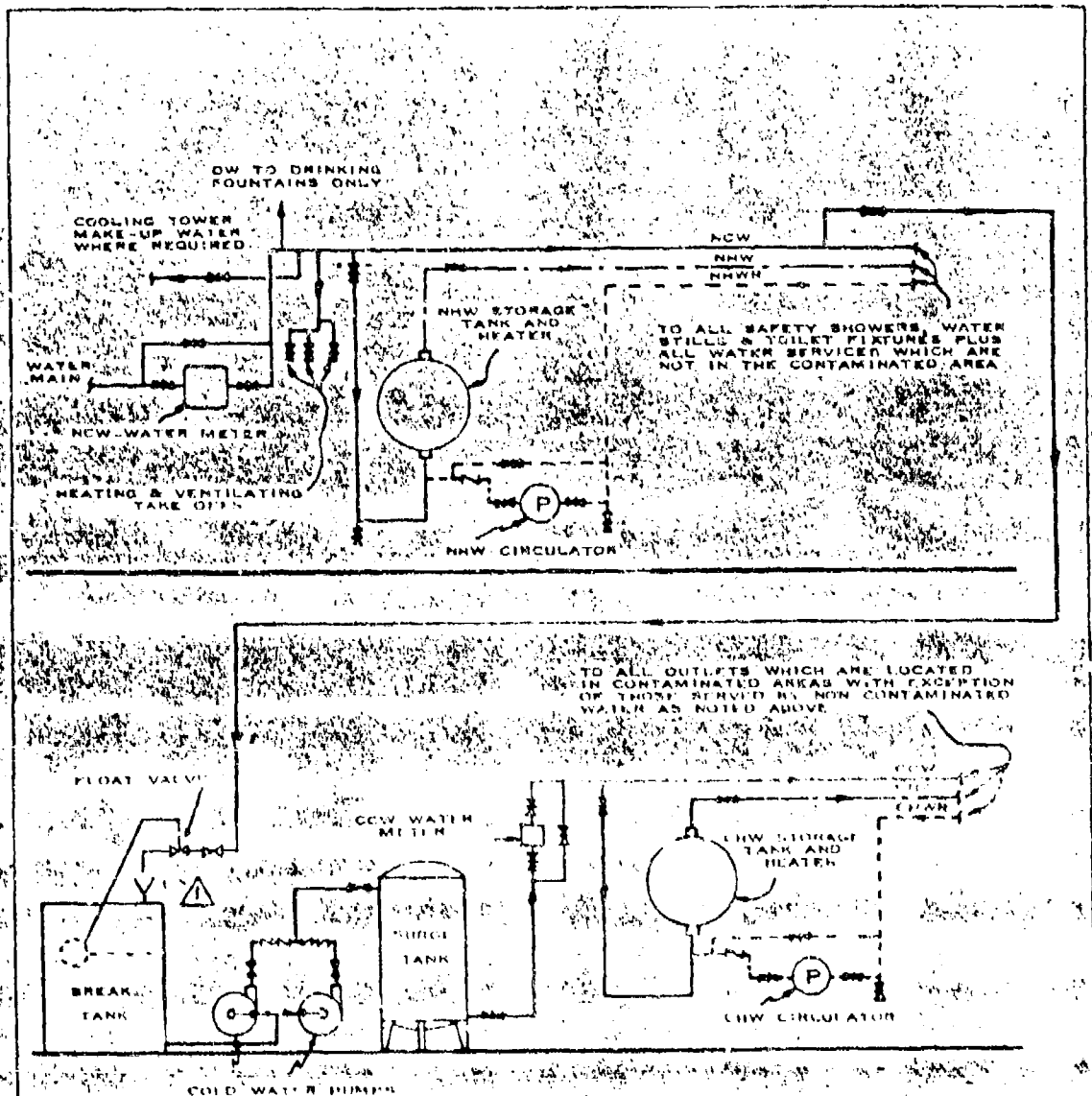
NOTES 1. VENTS FROM CLASS III BIOLOGICAL SAFETY CABINETS AND STERILIZERS SHALL BE EXHAUSTED THROUGH A CENTRAL COMBUSTION INCINERATOR IF AVAILABLE.

⚠ 2. HEPA = HIGH-EFFICIENCY PARTICULATE FILTER.
H.E. = HIGH-EFFICIENCY FILTER.

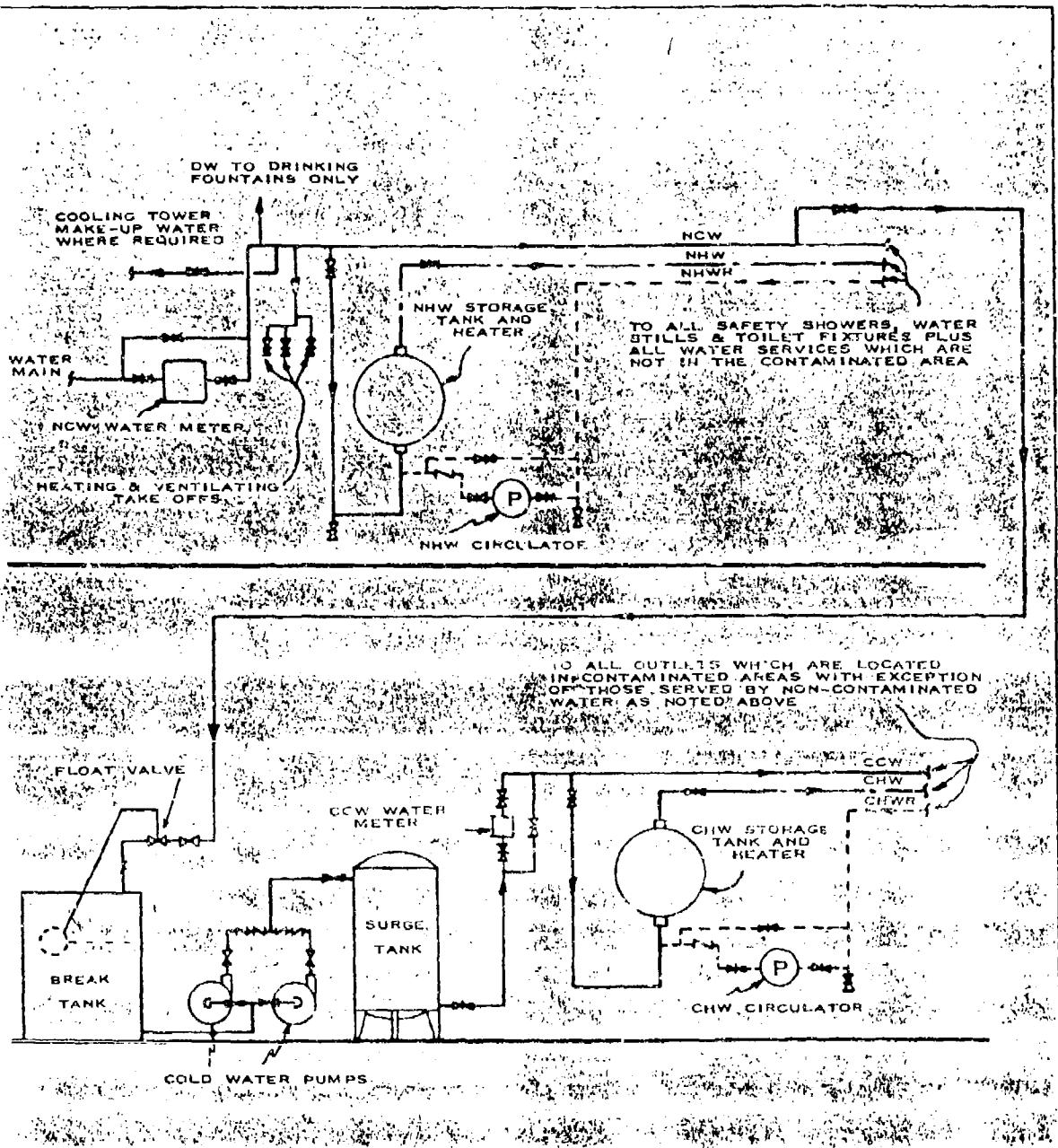
STERILIZER VACUUM, VENT, AND WASTE SYSTEMS

REV.	DATE	DESCRIPTION
⚠	3 AUG. 67	WAS U.H.E. FILTER
DATE - 1 FEB. '66		PLATE NO. 3.4

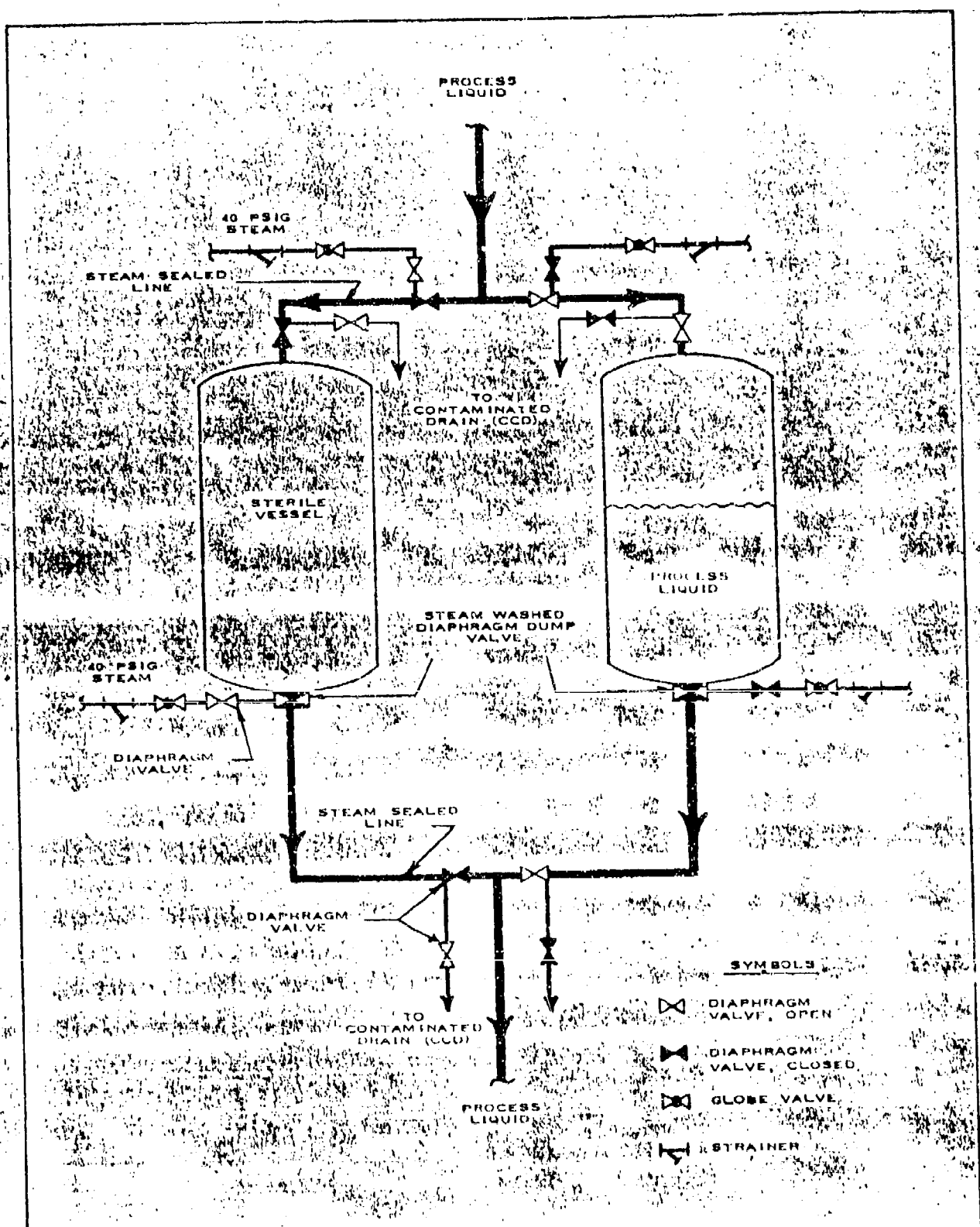
4/70



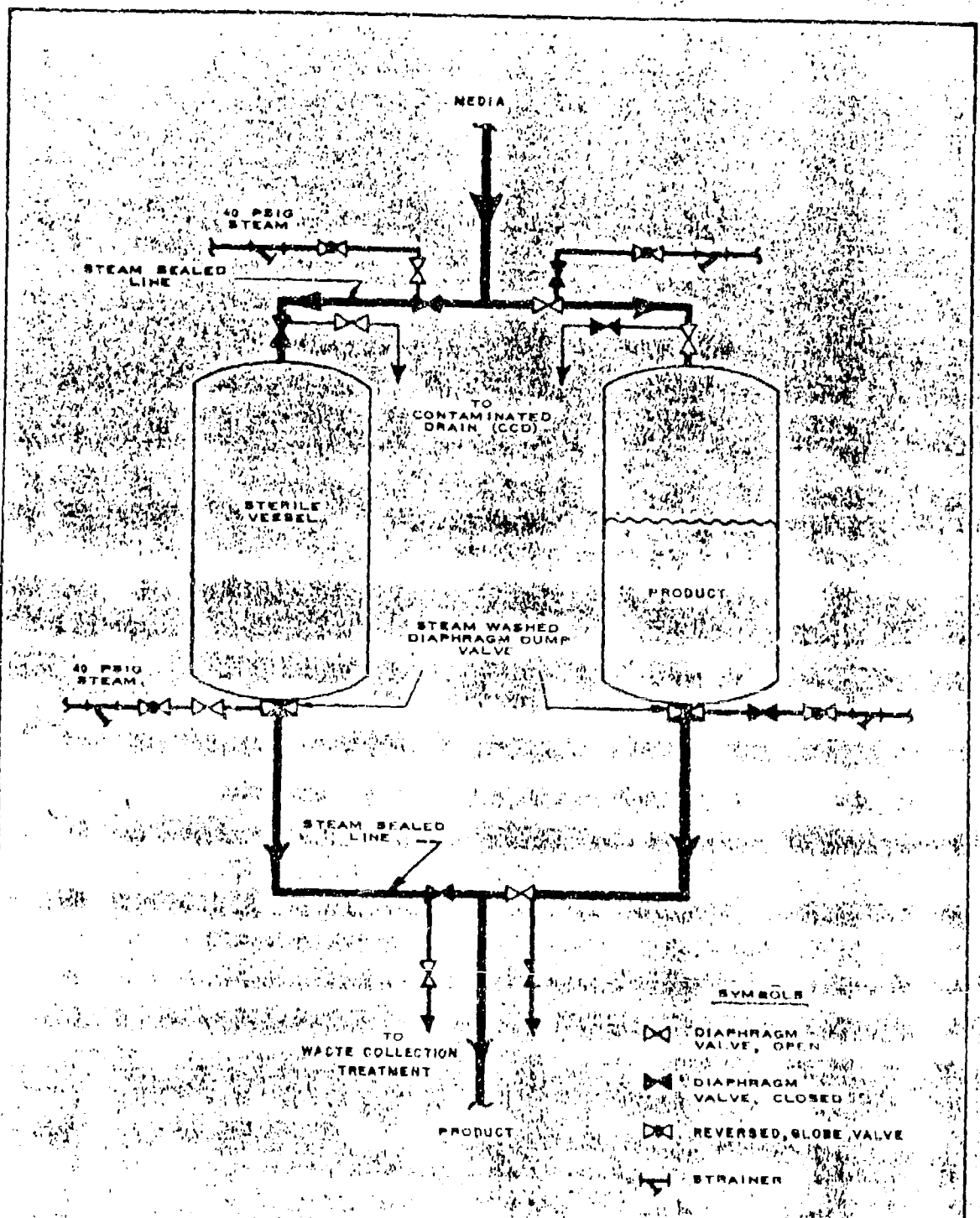
TYPICAL WATER PIPING HOOK-UP IN CONTAMINATED BUILDING	4	1-12-68	AIR BREAK IN NCW LINE
	NO.	DATE	DESCRIPTION
	DATE - 1 FEB. 68		PLATE NO. 3.5



TYPICAL WATER PIPING HOOK-UP IN CONTAMINATED BUILDING	REV.	DATE	DESCRIPTION
	DATE - 1 FEB. 66		PLATE NO. 3.3



TYPICAL STEAM SEALS			
	REV.	DATE	DESCRIPTION
DATE FEB. 66			PLATE NO. 3.4

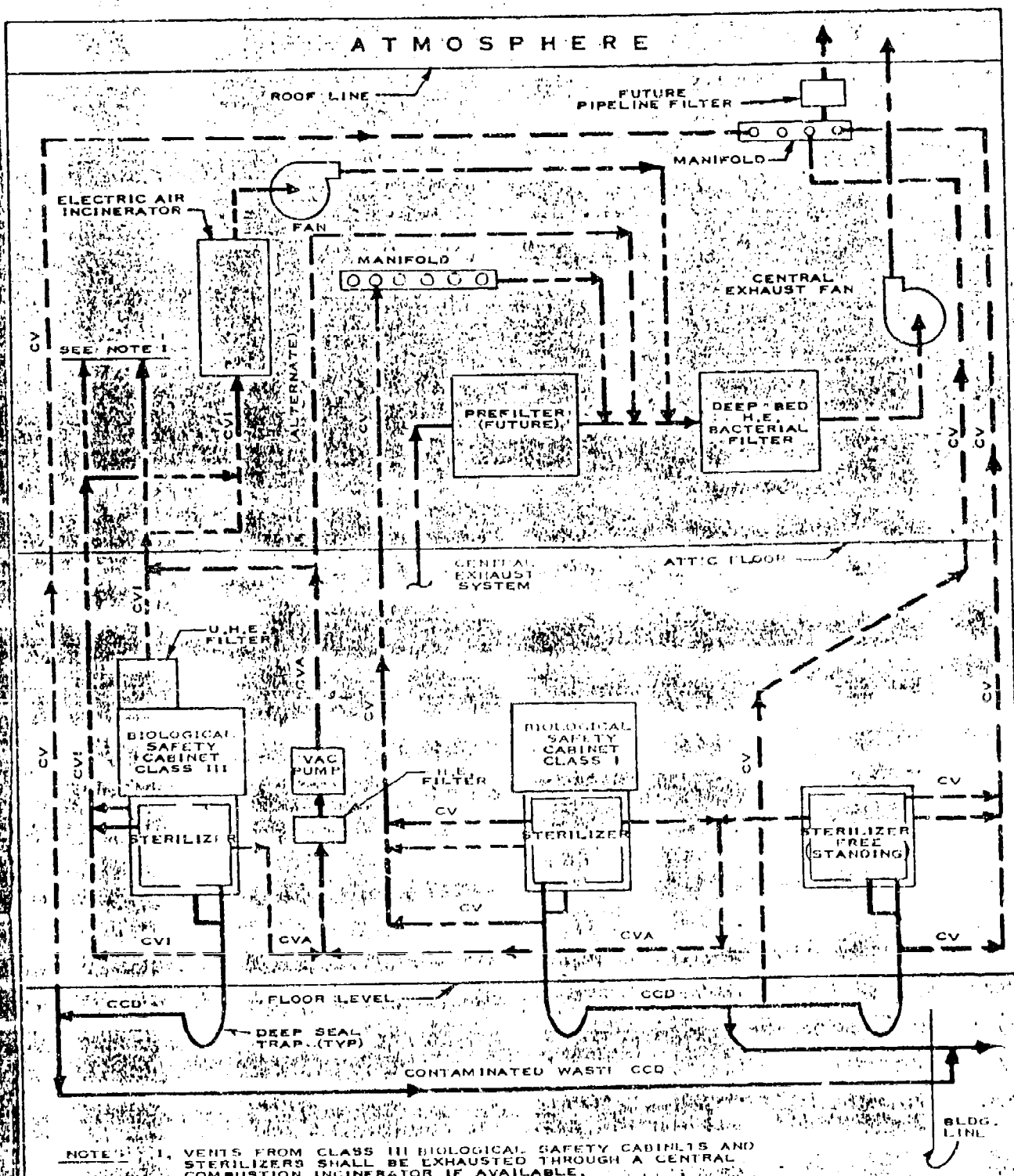


TYPICAL STEAM SEALS

REV.	DATE	DESCRIPTION
1	OCT 7	GENERAL REVISION

DATE - 1 FEB. 66

PLATE NO. 3.6



NOTES: 1. VENTS FROM CLASS III BIOLOGICAL SAFETY CABINETS AND STERILIZERS SHALL BE EXHAUSTED THROUGH A CENTRAL COMBUSTION INCINERATOR IF AVAILABLE.

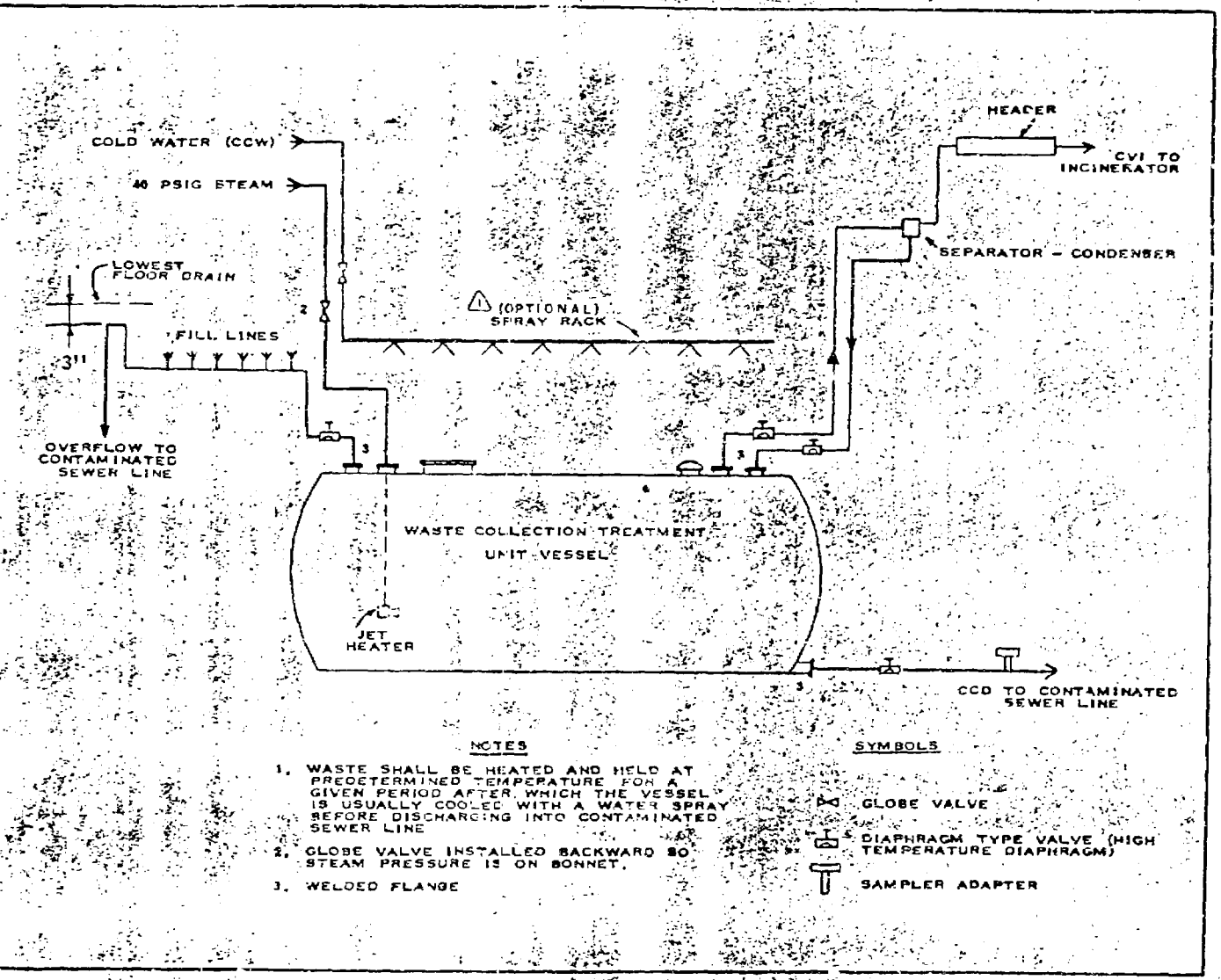
2. U.H.E. = ULTRA HIGH-EFFICIENCY FILTER.
H.E. = HIGH-EFFICIENCY FILTER.

STERILIZER VACUUM, VENT, AND WASTE SYSTEMS

REV.	DATE	DESCRIPTION
	DATE - 1 FEB. 66	PLATE NO. 3.5

3/68

WASTE COLLECTION TREATMENT UNIT DIAGRAM FOR BATCH STERILIZATION



REV.	DATE	DESCRIPTION
1	3 AUG. 67	ADDED "OPTIONAL"

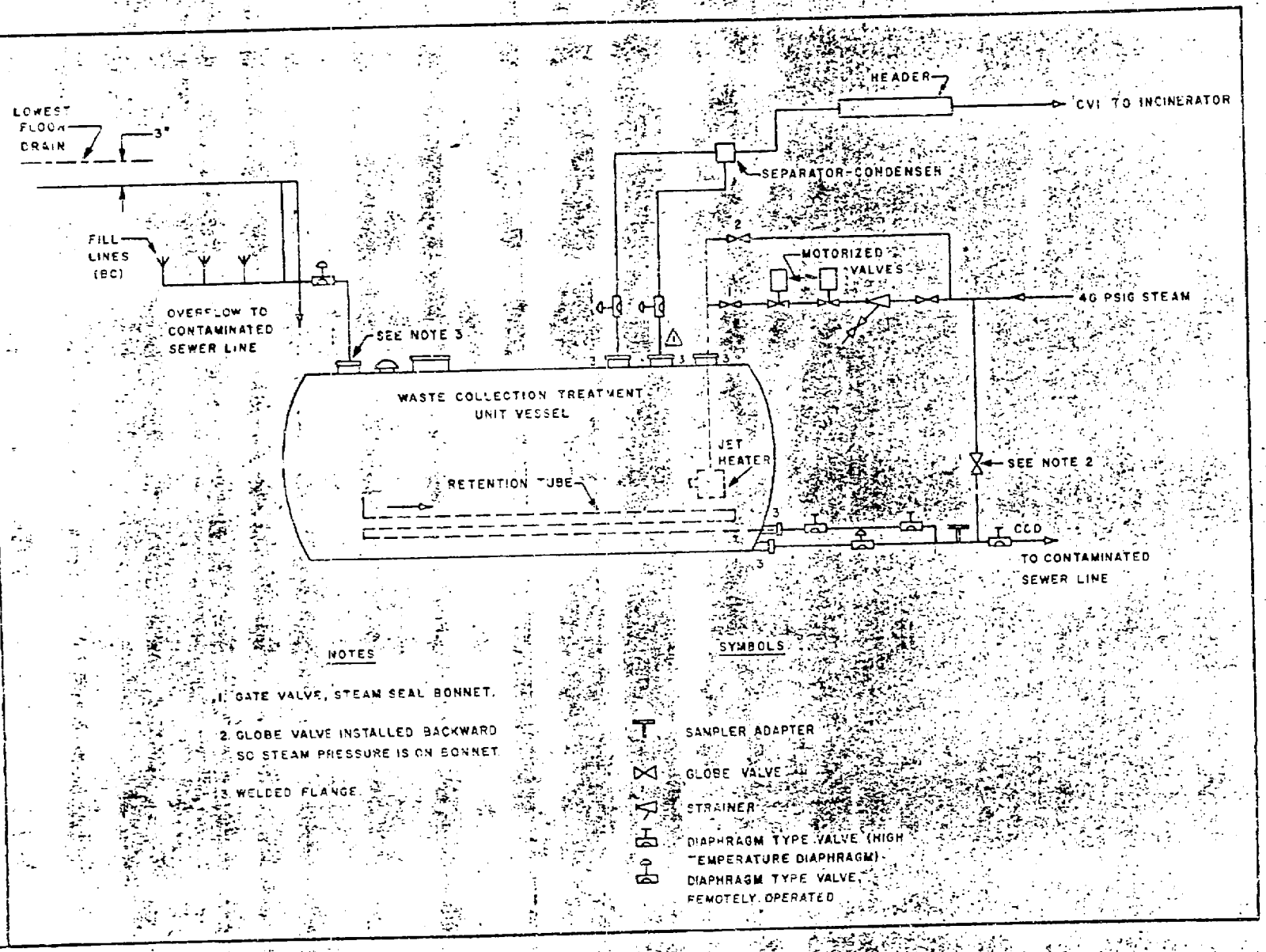
DATE - 1 FEB. 66

PLATE NO. 3.7

3.29A

3/66

WASTE COLLECTION TREATMENT UNIT DIAGRAM FOR CONTINUOUS PASTEURIZATION

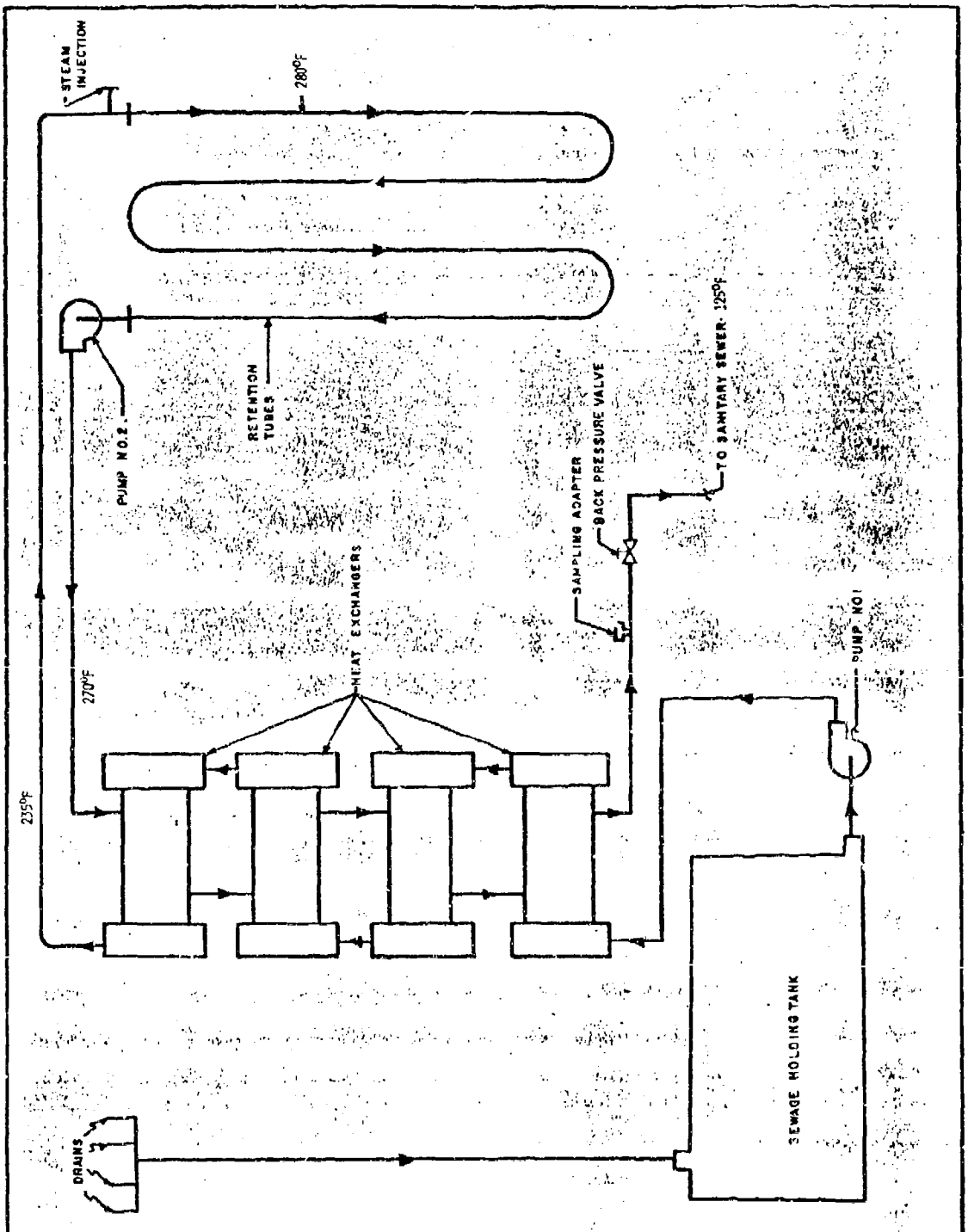


REV.	DATE	DESCRIPTION
A	4 AUG 67	ADDED SEPARATOR VALVE

DATE - 1 FEB 66

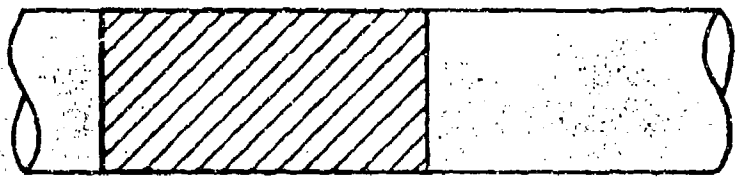
PLATE NO. 3.8

3.29B



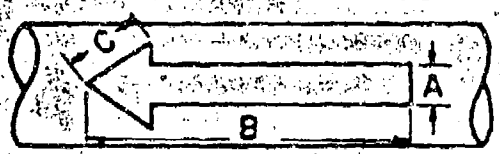
CONTINUOUS FLOW, HEAT EXCHANGER, SEWAGE STERILIZATION SYSTEM.	1	OCT. 69	GENERAL REVISION
	REV.	DATE	DESCRIPTION
	DATE - 1 SEPT. 67		PLATE NO.3.9

BASIC BAND COLOR

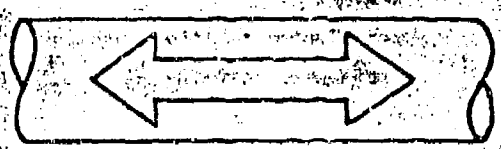


Width of band to be 2" for all pipe sizes for each color

SECONDARY ARROW COLOR



Direction of flow



Reversible flow

DIMENSIONS OF ARROW

Pipe or covering size	"A"	"B"	"C"
2" dia. or below	1/4"	2"	1/2"
2-1/2" dia or above	3/4"	3"	1-1/2"

PIPE SYMBOLS

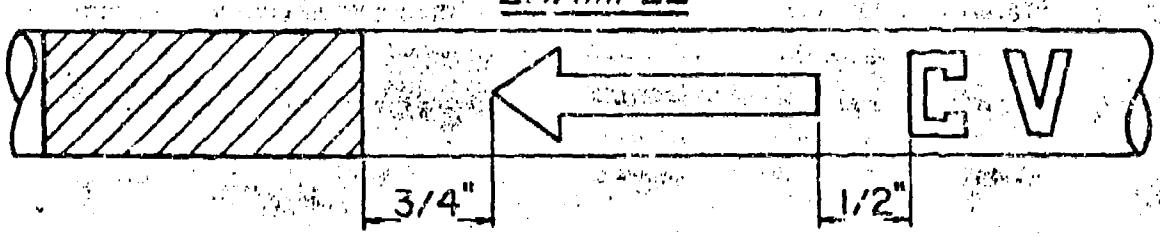
For use on 2" or less pipe or covering:

Height of letters-1/2"
Thickness of lines-3/32"
Spacing between letters-1/4"

For use on 2-1/2" or more pipe or covering:

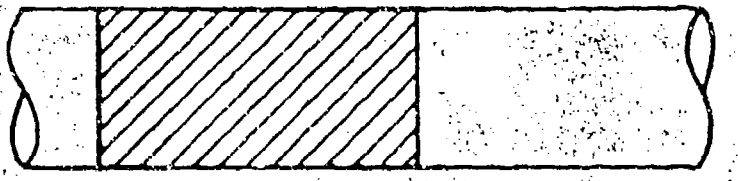
Height of letters-3/4"
Thickness of lines-1/8"
Spacing between letters-1/4"

EXAMPLE



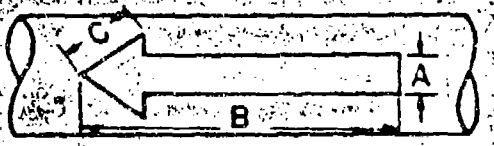
COLOR CODING FOR PIPING	REV.	DATE	DESCRIPTION
	DATE - 1 FEB. 66		PLATE NO. 3.6

BASIC BAND COLOR

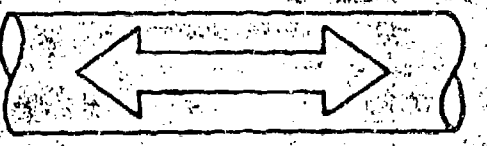


Width of band to be 2" for all pipe sizes for each color

SECONDARY ARROW COLOR



Direction of flow



Reversible flow

DIMENSIONS OF ARROW

Pipe or covering size	"A"	"B"	"C"
2" dia. or below	1/4"	2"	1/2"
2-1/2" dia or above	3/4"	3"	1 1/2"

PIPE SYMBOLS

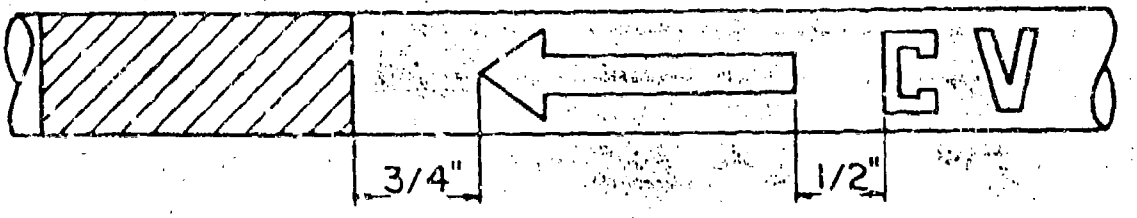
For use on 2" or less pipe or covering:

Height of letters-1/2"
Thickness of lines-3/32"
Spacing between letters-1/4"

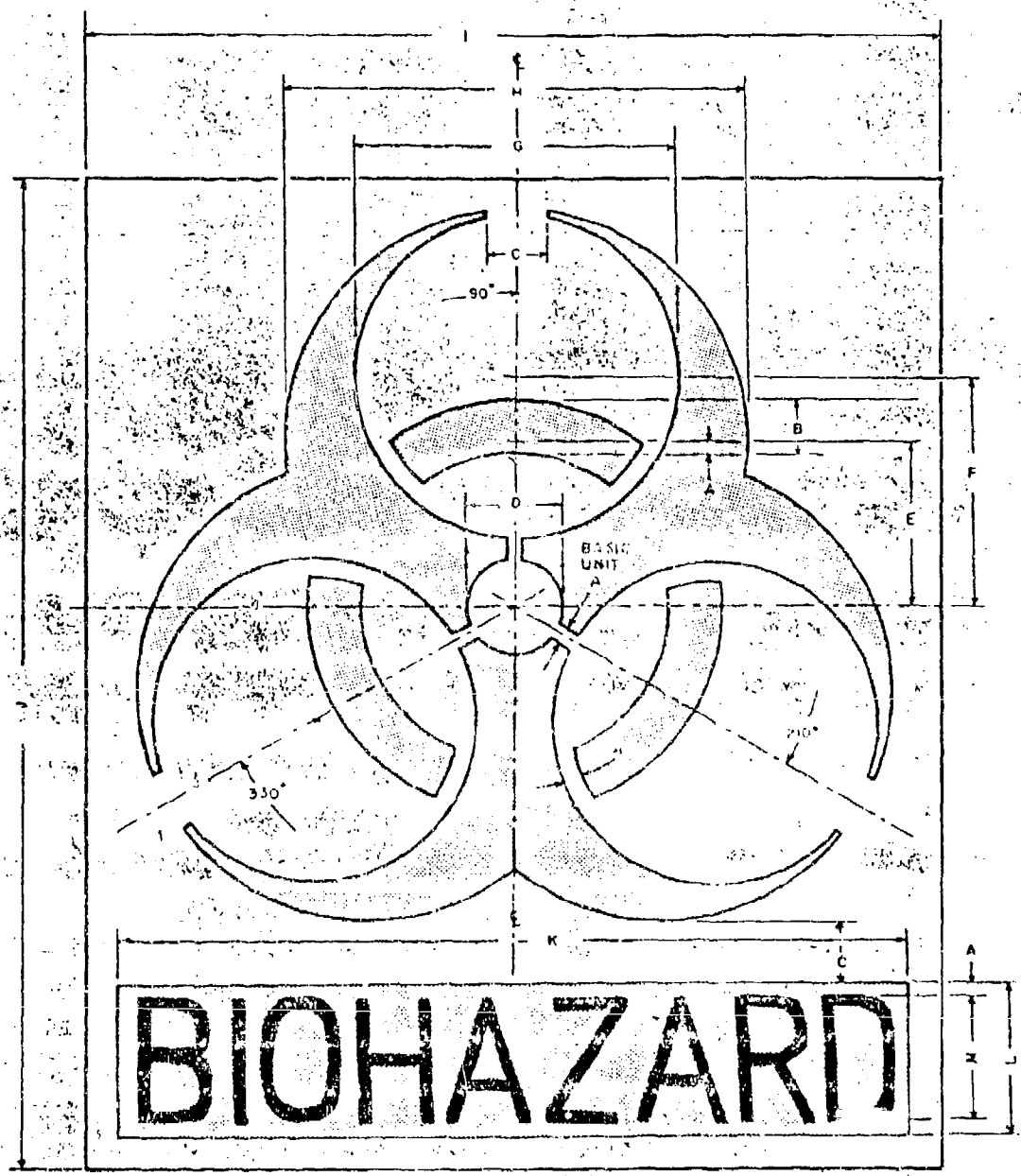
For use on 2-1/2" or more pipe or covering:

Height of letters-3/4"
Thickness of lines-1/8"
Spacing between letters-1/4"

EXAMPLE



COLOR CODING FOR PIPING	REV.	DATE	DESCRIPTION
		DATE - 1 FEB. 66	PLATE NO. 3.10



COLOR LEGEND

- FLUORESCENT ORANGE-RED
- BLACK
- WHITE

DIMENSION	A	B	C	D	E	F	G	H	I	J	K	L	M
UNITS	1	3½	4	6	11	15	21	30	56	65	52	10	R

BIOLOGICAL HAZARD WARNING SYMBOL

REV	DATE	DESCRIPTION
DATE-1 SEPT. 67		PLATE NO. 3.11

3.35B

SECTION 4 - EQUIPMENT AND ACCESSORIES

TABLE OF CONTENTS

/70

LIST OF PLATES

SECTION 4

EQUIPMENT AND ACCESSORIES

4-00 INTRODUCTION

A. Scope

This section is addressed primarily to those architect-engineering personnel concerned specifically with the engineering and design of equipment and accessories for the microbiological facilities at Fort Detrick. It does not include equipment for heating, ventilation, and air conditioning, which is covered in Section 2. It applies to new facilities, and to modifications and additions to existing facilities.

We repeat here again, as in every section, that the purpose of this manual is to present special design criteria based primarily on biological safety considerations. It is not intended to duplicate the fund of standards and criteria normally possessed by the architect-engineer. However, a sub-section of Fort Detrick Design Practices not related to safety considerations is given at the end of this section. In addition, Appendix A lists a number of Fort Detrick Purchase Descriptions and Specifications.

As described in Volume 1, Fort Detrick contains a variety of facilities, such as laboratories, pilot plants, test chambers, filling lines, storage areas, and others. This manual presents the criteria that all of these facilities have in common. To avoid vagueness, many of the criteria are stated in terms of laboratory buildings, but this should not be taken to mean that they are not generally applicable.

With some exceptions, the requirements peculiar to each type of facility are not covered in this manual.

B. Conversions and Modifications

The application of the criteria presented here to the design of new facilities generally will be straightforward. However, many projects involve the conversion or modification of existing facilities. Since these facilities were built there have been changes in the criteria, based on technical innovations or operating experience. As a result, it is important for the designer of such modifications to exercise judgment and flexibility in applying the new criteria. Some of the potential problems will be resolved by the specific Contract Scope of Work for the individual project or by other guidance provided by the Government.

C. General Principles

1. Confinement: Equipment must be designed for the protection of personnel in agent areas by limiting and controlling contact with biological agents. Equipment must also meet certain tests in order to be acceptable in agent areas (such as the halogen leak test, as described in Section 4.18). Special seals are required for rotating shafts in areas where they enter agent equipment.

2. Materials of Construction: Materials of construction besides meeting structural strength requirements must also be non-toxic to agents where used in contact with them (except in waste collection treatment units). Materials must also be able to withstand the corrosion caused by a variety of chemical decontaminants, and particular care should be taken in using dissimilar metals to prevent galvanic corrosion. Where field welding is required, low carbon stainless steel must be used to prevent embrittlement or carbonization at welds. To prevent the possibility of "pin hole" leaks, no castings for enclosures will be allowed.

3. Fabrication: To facilitate cleaning and to prevent the accumulation of contaminants, equipment such as cabinets shall have no pockets, burrs, or sharp corners. Floor of cabinets shall be sloped to the drain.

4. Installation, Operation, and Maintenance: Equipment shall be designed, constructed, and installed to facilitate simple operation, ease of maintenance, accessibility for cleaning, and ease of decontamination. Equipment located in safety cabinets will not be readily accessible, so that shut-down will be critical and costly, and care in design is therefore essential.

5. Economy: Equipment design and fabrication must provide the best overall economy with due consideration to procurement, installation, operation service, maintenance, and decontamination costs. Commercially available equipment should be used whenever it meets the requirements or when it can be economically modified to meet the requirements by specifying different materials of construction, special shop coatings, or other changes.

D. Organization of Section 4

The remainder of this section is divided into sub-sections that describe both standard and special equipment peculiar to a microbiological laboratory, such as safety cabinets, animal cages, refrigerators, incubators, sterilizers, etc. The final sub-section is concerned with Fort Detrick Design Practices not related to safety.

4-01 BIOLOGICAL SAFETY CABINETS

A. General: The safety cabinet is the most important single piece of equipment for prevention of laboratory infections. Safety cabinets are widely used at Fort Detrick, either as individual units, or by joining

a number together to form a cabinet system. There are three basic kinds of safety cabinets, differing in the degree of confinement of biological materials. The Class I safety cabinet is dependent on a high-velocity air flow into an opening in the front, through which the worker can pass his hands. It is similar to a chemical fume hood in this respect, but differs considerably in structural details. The Class III safety cabinet is gastight, with the work done through attached rubber gloves, and is therefore suitable for more hazardous work than the Class I and laminar airflow cabinets. The Class III cabinet is maintained at a negative pressure, and is ventilated at a relatively low rate. The laminar airflow safety cabinet has a vertical flow recirculating air system and is generally operated as an open-front cabinet. This cabinet provides a sterile work environment and is at least as effective as the Class I cabinet in preventing airborne particulates from escaping from the cabinet.

Class I, Class III, and laminar airflow cabinets are made of stainless steel and are similar in their basic construction. The cabinet units are furnished with viewing windows, glove ports, service piping, and electrical outlets as required. They also may be furnished with openings in the rear or bottom surface for attaching equipment such as refrigerators, deep freezers, sterilizers, and incubators, or accessories such as disinfectant dunk baths, centrifuge wells, and pass boxes. They are provided with filters for treating exhaust air.

Conveyors and elevators may be used in safety cabinet systems for horizontal and vertical transfers. They are made of stainless steel and may be electrically, pneumatically, or hydraulically operated.

B. Reference to Other Sections

1. Services and Drains: See 3-02 and 3-04, PIPING.

2. Electrical: See 5-04, ELECTRICAL.

3. Ventilation: See 2-06 and 2-07, HV&AC.

C. Class I Cabinets

1. Description: Plate 4.1 is a photograph of a single Class I cabinet. Plate 4.2 shows a similar cabinet with the front opening closed by inserting a glove panel and an entrance airlock attached to the right side. While providing greater confinement, the closed Class I cabinet does not meet the gastight requirement of the Class III cabinet.

2. Required Use: See 1-07 B, ARCHITECTURAL.

3. Design Features

a. An adapter is used to mount a 300-cfm air filter on the top of the cabinet to filter exhaust air.

b. Class I type cabinets shall be designed and located so that accessory equipment can be attached at either end of the cabinet if necessary. Class I cabinets should be located away from doorways and room air supply openings to prevent back-drafts that might allow escape of contaminated air.

D. Laminar Airflow Safety Cabinets

1. Description: Plates 4.2a and 4.2b are photographs of typical laminar airflow cabinets. Plate 4.2c shows the airflow patterns in one type of laminar airflow cabinet. Plate 4.2d shows the parts and arrangement of one type of laminar airflow cabinet.

2. Design Features: Laminar airflow cabinets have downward air flow systems, with the air passing through HEPA filters that cover the entire ceiling of the cabinet. Vertical airflow at every point within the cabinet is 100 lfm ± 20%. Generally, a solid work surface is used with perforated grills running along the front 5" of the cabinet floor and along the 5" lower back wall of the cabinet. As air passes by the open front of the cabinet, air from the room is drawn into this air stream and enters the front intake grill.

3. Tests

a. A standard DOP test should be carried out on both the recirculating HEPA filter and the exhaust air filter after the cabinet is received and installed and after filters have been changed. A reading of 99.97% removal of the 0.3-micron DOP particles should be obtained across the entire surface of the filters.

b. A bacteriological evaluation of new cabinets should be carried out before the cabinet is used with infectious materials. These bacteriological tests will determine the product and operator protection provided. First, a heavy aerosol of a test microorganism should be set up outside the cabinet with the aerosol generators directed toward the open front of the cabinet. About 45 open petri dishes containing appropriate media will be spread across the floor of the cabinet.

All petri dishes should remain sterile after being open for 30 minutes during aerosol generation. To determine operator protection, a heavy aerosol of a test microorganism will be generated within the cabinet. Slit- or sieve-type air samplers will be placed in the room, especially near the open front of the cabinet. No escape of microorganisms should occur during the 30 minutes in which the aerosol is being generated.

E. Class III Cabinets

1. Description: Plate 4.3 shows an array of Class III safety cabinets.

2. Required Use: See 1-07 C, ARCHITECTURAL.

3. Design Features

a. The Class III cabinet provides a work space surrounded by a gastight envelope. The cabinet must be sealed to contain Freon-12 under 3 inches w.g. pressure when leak-tested. (For halogen leak test standards see 4-18.)

b. Inlet and exhaust air pass through bacterial filters (see 2-06 D, HV&AC).

c. The Class III cabinet is maintained at lower pressure (between -3/4" and -2" of water) than the surrounding laboratory atmosphere.

d. All contents, once exposed to the interior of the Class III cabinet, are sterilized before they are released to the surrounding environment.

e. The Class III cabinets are to be constructed of 304 stainless steel and other materials required shall be compatible with the various gaseous and liquid decontaminating agents in use. Elimination of cracks and crevices is paramount in fabrication to provide smooth surfaces for ease of decontamination. Any requirements for special decontaminants will be supplied by the Government.

f. Cabinet Seals: Class III biological safety cabinets have flanged ends and are joined together by positioning bolts and spacers, then sealed by an elastomer sealant. Experience has shown that gastight enclosures can be achieved with an elastomer sealant as specified in subsection 1-06 A, ARCHITECTURAL. Earlier designs made use of bolted flanges with gaskets and are currently in use; however, all new construction will be of the elastomer sealant design. Class III cabinet penetrations for rotating or moving equipment will require special seals. Double O ring liquid seals may be used provided that the design results in a gastight seal.

g. Cabinet Systems: Class III biological safety cabinets are furnished as units, usually 34" or 68½" long. These units may be joined to make continuous lengths of an integral safety cabinet system. Usually the extent of one integrated cabinet system is confined to one laboratory room. However, in some instances the cabinet system may pass through a partition and extend into an adjoining laboratory room. In other instances, what appears to be one system of cabinets may actually contain several sections that are isolated by doors inside the cabinets, and are considered as separate cabinet systems. Cabinet branches may likewise be isolated by doors in the cabinet system.

h. Doors: The door normally used in the Class III cabinet system is the DBO type manually operated door (see Fort Detrick Drawing F-93-1-6616). Other types of doors may be required where door swing is hampered by equipment or for other reasons. Changes from the standard DBO door shall be subject to approval by the Government. Any door used to separate sections of a cabinet system must be gastight and will be required to meet the cabinet leak test requirements (see 4-18).

i. Air Inlet and Exhaust Location: See 2-06 D, HV&AC.

j. Filters and Ventilation: See 2-06 D, HV&AC.

k. Services: See 3-02 and 3-04, PIPING, and 5-04, ELECTRICAL.

l. Shapes and Sizes: The cabinet units are available in various sizes and shapes, and any of the units having different cross sections may be joined by adapter plates. The cabinets are available in single modular width of 34" and double width of 68⅝". Shapes are designed for both single-side and double-side operation. Attaching special equipment such as incubators, refrigerators, and deep freezers at the ends, rear, or bottom of most types of cabinet is provided for by special openings and adapter plates.

m. Biological Safety Cabinets Catalog: A two-volume catalog entitled "Biological Safety Cabinets" (1965) has been prepared to assist in selecting the proper type and size cabinets with optional accessories desired. The catalog describes all approved types and their applicable reference drawings for fabrication. Copies of the catalog are available from the Government.

4. Cabinet Attachments: The following equipment may be attached to a number of the Class III biological safety cabinet.

a. Refrigerator: A Class III biological cabinet bottom-mounted refrigerator may be used in conjunction with the normal Class III cabinets. See subsection 4-03, Refrigerators, below.

b. Incubator: A Class III biological cabinet incubator may be used in conjunction with the normal Class III cabinets. See subsection 4-05, Incubators below.

c. Deep Freeze: A Class III biological cabinet bottom-mounted deep freeze may be used in conjunction with the normal Class III cabinets. See subsection 4-03, Deep Freeze, below.

d. Centrifuge Well: A Class III biological cabinet bottom-mounted centrifuge well may be used in conjunction with the normal Class III cabinets. See Fort Detrick Drawing F-93-1-4007-4 for details.

e. Dunk Tank: A Class III biological cabinet bottom-mounted dunk tank to hold chemical decontaminating solution may be used in conjunction with the normal Class III cabinets. See Fort Detrick Drawing F-93-1-4007-1 for details.

f. Sterilizer: One or more back-mounted gastight double-door sterilizers, fitted for use with steam and gas, are generally used in conjunction with a Class III cabinet system.

g. Pass Box: A Class III biological cabinet pass box may be used in conjunction with the normal Class III cabinets to provide access to the cabinet system.

4/70

4-02 ANIMAL CAGES AND CAGE RACKS

A. Animal Cages: Animal cages are the units in which animals are lodged while awaiting or undergoing experiments. The cages may be either ventilated or non-ventilated, depending upon the requirements (see Plates 4.4, 4.5, and 4.6). Details on the different types and sizes of cages available for various animals are given in Fort Detrick Purchase Descriptions.

1. Ventilated: Ventilated cages are units in which air is supplied and exhausted from the cage by an external exhaust blower system. The use of inlet and exhaust filters on the individual cages results in the isolation of the animal from the room and from animals in other cages.

2. Non-ventilated: Non-ventilated cages are open units in which the animals are exposed to the environmental condition of the room and share the general room ventilation.

a. Cages to be used with racks equipped with ultraviolet light shall have solid sides to protect the animals from radiation.

B. Animal Cage Racks: Animal cage racks are the units on which the animal cages are housed. Animal racks may be ventilated or non-ventilated depending upon the type of animal cage they will house.

1. Ultraviolet: Animal cage racks used for holding infectious animals shall be equipped with adjustable ultraviolet fixtures and reflectors (see Plates 4.7, 4.9, and 5-03 B, ELECTRICAL).

2. Ventilated: See Plates 2.2, 4.7, and 4.8. For ventilation see 2-07 B, HV&AC.

3. Non-Ventilated: See Plate 4.9.

a. The rack shall have a solid shelf above the top cage to protect animals in open top cages from possible drafts caused by overhead air diffusers.

b. The underside of each shelf shall be painted with a low-reflecting, non-gloss paint to reduce reflectance of U.V. radiation into the non-ventilated cages.

c. For ventilation see 2-05 B, HV&AC.

4-03 REFRIGERATORS

A. Required Use: See 1-07 E, ARCHITECTURAL.

B. Walk-In Refrigerator Room: See 1-03 H, ARCHITECTURAL.

C. Laboratory, Free-Standing: A free-standing laboratory-type refrigerator may be provided in any laboratory.

1. Laboratory, Below Bench Top: The refrigerator may be installed below laboratory bench tops for localized storage or as a space saving feature.

2. Modification of Controls: All free standing refrigerators shall have the interior light switch and thermostat removed and the controls mounted outside the refrigerator.

3. Insulation: Insulation for this equipment is not required to be non-halogen-liberating (see also 4-19).

4. Details of Construction: Details of construction are given in Fort Detrick Purchase Descriptions.

D. Safety Cabinet: A refrigerator for use in a Class III cabinet system may be provided as a bottom-mounted unit attached to the safety cabinet by an adapter plate; it will be required to meet the safety cabinet leak test requirements, see 4-18. For details of a standard bottom-mounted refrigerator see Fort Detrick Drawing F-127-3-2076.

1. Insulation: Insulation must not liberate halogens, since these would interfere with leak-testing of the safety cabinet (see also 4-19).

E. Safety Markings: All refrigerators located in contaminated areas, except those connected to a Class III cabinet, shall be appropriately marked with an 8-inch brown circle, lettered above in brown with "In Case of Fire Place All Infectious Cultures Here" and below with "Firemen Keep Out Unless Supervised."

F. Controls: For controls and alarms, see 6-05 C, INSTRUMENTATION.

G. Deepfreeze

1. Free Standing: A household-type deepfreeze chest or upright unit may be required for specific application. Deepfreeze units shall be constructed of corrosion-resistant material and have a smooth finish inside and out. They shall be equipped with adjustable shelves and have exterior-mounted controls.

2. Safety Cabinet: A deepfreeze for use in a Class III cabinet system may be provided as a bottom-mounted unit. This unit is attached to the safety cabinet by an adapter plate and will be required to meet the safety cabinet leak test requirements, see 4-18. For details of a standard bottom-mounted deepfreeze see Fort Detrick Drawing F-127-3-2076.

3. Safety Markings: All deepfreezes located in contaminated areas, except those connected to a Class III cabinet, shall be appropriately marked as indicated above, see 4-03 E, Safety Markings.

4-04 INCINERATORS

A. Combustion Air Incinerator: A combustion-type incinerator shall be used to incinerate all effluent air from Class III biological safety cabinet

systems (except as provided by 4-04 B below), aerosol chambers, waste collection treatment units, discharge air from process equipment, and any other unit that may discharge contaminated air. See Section 6-05 E.3, INSTRUMENTATION for operational details.

B. Electric Air Incinerator: An electric air incinerator shall be used to incinerate all effluent air from Class III cabinet systems whenever a combustion-type incinerator is not available.

C. Refuse Incinerator: Where it is economically desirable because of the building size and amount of combustible trash, a local building incinerator may be installed. Where such use is specified, appropriate criteria will be furnished by the Government.

4-05 INCUBATORS

A. Required Use: See 1-07 E, ARCHITECTURAL.

B. General

1. Incubators shall be of all-metal construction.

2. Forced-convection type incubators shall be permitted only in Class I or Class III safety cabinet systems.

3. All incubators shall be compatible with the standard Fort Detrick egg tray, see Fort Detrick Drawing F-93-1-6728.

4. All controls shall be externally mounted and explosion-proof.

5. Special sensitivity incubators shall be water-jacketed for close temperature control.

6. Insulation for incubators is not required to be non-halogen-liberating (see also 4-19) except for incubators attached to Class III safety cabinets (see 4-05 E below).

C. Walk-In Incubator Room: See 1-03 H, ARCHITECTURAL.

D. Laboratory: A bench top laboratory incubator may be provided in any laboratory as required.

E. Safety Cabinet:

1. Incubator: An incubator for use in a Class I or III cabinet system may be provided with a bottom-mounted unit or a Class III incubator cabinet. These units are attached to the safety cabinet by an adapter plate and shall be required to meet the safety cabinet leak test requirements (4-18). For details of a bottom-mounted incubator see Fort Detrick Drawing F-127-3-2077; for the incubator cabinet see Drawing F-93-1-6675.

2. Insulation: Insulation must not liberate halogens because these would interfere with leak-testing of safety cabinet (see also 4-19).

F. Safety Markings: All incubators, except those connected to a Class I or III safety cabinet, shall be appropriately marked as indicated above, see 4-03 E, Safety Markings.

G. Controls: For humidity controls and alarm, see 6-05 D, INSTRUMENTATION.

4-06 STERILIZERS

A. Required Use: See 1-07 D, ARCHITECTURAL.

B. Requirements

1. All steam sterilizers (autoclaves) shall be double-jacketed, single- or double-door type, with door swings as dictated by the installation, and shall conform to the requirements of Fort Detrick Purchase Descriptions and Specifications.

2. All sterilizer that attach to Class I and Class III biological safety cabinets are to have stainless steel sealing flanges either welded to the sterilizer outer shell or cast into the head ring.

3. Sterilizers extending through walls that separate non-contaminated areas from contaminated areas shall have a complete wall seal surrounding the outer jacket, including the sealing of all piping, conduits, and controls that extend through the wall. An acceptable method for sealing sterilizers is shown on Plate 4.10. Plate 4.11 is a photograph of a similar seal used with a pass box.

a. The doors shall have interconnected indicator lights to alert the operator when either door is open. These lights minimize the possibility of having both doors open simultaneously between a contaminated and noncontaminated area. In general, the use of interlocked doors on double-door sterilizers is not required, but may be requested by the Government.

4. The steam header pressure to autoclaves shall be 40 psig, except for high-vacuum sterilizers, which may require 100 pounds of steam.

5. Sterilizers may be operated either manually or automatically, depending upon usage or needs. Automatic controls are usually not required.

6. All gas sterilizers and autoclaves, except sterilizers with automatic controls, shall be equipped with a flapping metal sign indicating STERILE and CONTAMINATED and mounted on front of the sterilizer.

C. Size: See 4-20 B, Fort Detrick Design Practices.

D. Conversion for Gas: Any steam sterilizer may be converted to a gas sterilizer for use with a Freon-ethylene oxide gas mixture. The manifold assembly for introducing this gas mixture into the sterilizer shall be in accordance with Plate 4.13.

1. Vacuum for exhausting the sterilizer shall be provided by the CVA system, see 3-02 D, PIPING.

E. High-Vacuum Steam Sterilizer: A high-vacuum steam sterilizer shall be used when rapid sterilization of material is needed. Either a steam jet ejector or a special high-vacuum pump (at the option of the Government) may be used to evacuate the sterilizer prior to steam entry.

F. Powered Doors: Sterilizers may be installed with powered doors. The use is not to be considered mandatory but is highly desirable for cabinet systems because spatial arrangements within the cabinet make manual operation very difficult.

G. Installation: For piping and plumbing requirements of sterilizers or autoclaves see 3-02 A.4 and 3-04 H, PIPING.

H. Drains and Vents: For drainage and venting of sterilizers or autoclaves see 3-04 H, PIPING.

I. Controls: See 6-05 F, INSTRUMENTATION.

J. U.V. Chamber: See 1-02 B.4, ARCHITECTURAL.

4-07 WASHING EQUIPMENT

A. Glassware Washer

1. For ventilation of large glassware washer, see Section 2-05 C, HV&AC.

2. For controls, see 6-05 H, INSTRUMENTATION.

B. Cage Washer

1. Cage washing equipment shall be supplied for cleaning animal cages and/or boxes that have already been sterilized.

2. Large-scale units shall be equipped with fully automatic cleaning agent dispensers to keep the required concentration of agent in the wash tank at all times.

3. For ventilation of cage washers, see Section 2-05 C, HV&AC.

4. Details of construction are given in Fort Detrick Purchase Descriptions.

C. Ultrasonic Washing Equipment: When ultrasonic washing equipment is required, standard commercial units are used.

4-08 WASTE COLLECTION TREATMENT UNITS (Blowcase)

A liquid waste collection treatment unit shall be provided when large amounts of infectious material will be created during facility operation and are to be dumped into the sewage system. See Section 3-04 I, PIPING for required use and details of this system.

4-09 LABORATORY FURNITURE

A. Materials of Construction: All laboratory furniture which will be located in potentially contaminated areas shall be manufactured of a material impervious to biological agents and shall be corrosion-resistant to the decontaminating solutions used for washdown. Those specific furniture items which will be exposed to acid, alkali, or solvents shall be manufactured of suitable corrosion-resistant material for this type of service. The use of wooden furniture is prohibited.

1. Stainless Steel Tops: Table tops, backsplash, and drainboards (except those housing acid wells and baths) in glassware washing rooms, in cage washing rooms, and in laboratories devoted to biological safety cabinet systems for routing, diluting, plating, and plate counting of infectious materials shall be constructed of stainless steel (Type 304), No. 16 gage, supported on steel pipe legs. The stainless steel shall be spot welded to heavy channel reinforced steel frame. Legs may have adjustable screws on the bottom for leveling. The table top must be sound-deadened and storage space shall be provided by small removable sliding cabinets placed under the tables. All joints in table top, backsplash, and drainboards shall be butt-welded and ground to form an integral smooth, flush surface. A beaded front edge to prevent frontal drainage shall be provided on all glassware washing and cage washing table tops.

2. Stainless Steel Sinks: Sinks, drainboards, and backsplash installed in glassware washing and animal holding rooms, in laboratories where the use of corrosive chemicals is contemplated and sinks associated with stainless steel table tops shall be stainless steel, Type 304 and/or Type 316, No. 14 gage. Sinks shall be butt-welded integral to the tops with invisible flush seam.

3. Acid Baths: Acid baths, acid wells, covers, and adjoining drainboards shall be constructed of a material impervious to acids. Acid baths and wells shall be integral to the drainboard with invisible flush seams.

B. Finish: All metal laboratory furniture (other than stainless steel) including cabinets, drawers, desks, doors, tables, and wall cases shall be finished with an acid, alkali, and solvent resistant paint. All exposed stainless steel including the welds shall be ground and polished to a No. 2B finish.

C. Caulking: Acid and solvent resistant elastic sealing compound, as specified under sub-section 1-06 A, ARCHITECTURAL, shall be used to seal all joints and cracks in curbs and reagent shelves and where table tops, curbs, cabinets, and reagent shelves abut wall or other furniture.

D. Sloping Cabinet Tops: All contaminated laboratory storage cabinets, lockers, wall hung cabinets, and similar furniture which do not extend to the ceiling, shall have tops sloping to the front to prevent buildup of dust and facilitate drainage after washdown with decontamination solutions.

E. Flammable Material Storage Cabinet: See 1-03 J, ARCHITECTURAL.

F. Radiological Hood

1. For required use see 1-07 F, ARCHITECTURAL.

2. Outside dimensions of radiological hoods shall be either four (4) or six (6) feet in length (depending upon individual laboratory requirements) by three (3) feet six (6) inches wide by approximately eight (8) feet high, and shall have removable ends and panels. The frame for the base of the hood shall be constructed of structural steel to support a load of 4000 pounds. The counter top shall be reinforced to support the same load equally distributed. The entire interior and exterior of the hood shall be fabricated of type 304 stainless steel with 2B finish. The working surface is a stainless steel pan resting on a steel grating so that lead bricks can be used. The entire working surface is 3/8 inch deep, watertight to collect spillage. The hood is to have a five (5) inch diameter stainless steel sink welded into the pan. The sash is to have stainless steel side channels and be suspended on stainless steel and Monel cables and glazed with ¼ inch D.S. safety glass.

3. Before radiological hoods are specifically selected, the Government shall be consulted as to the type of hood to be used.

4. The radiological hood shall be equipped with an interconnected modulating by-pass damper that will maintain constant air flow to the fan regardless of the position of the front viewing window.

5. For ventilation requirements see 2-07 C, HV&AC, and for piping see 3-04 B.3, PIPING.

G. Chemical Fume Hood

1. The chemical fume hood shall be equipped with a by-pass damper as discussed in sub-section 4-09 F.4 above.

2. For ventilation requirements see 2-07 C, HV&AC, for piping and plumbing see 3-04 E, PIPING.

H. Other Furniture

1. Desks

a. Laboratory desks shall be of steel construction.

b. Utility desks shall be of steel construction, wall-mounted, with sloping top.

2. Chairs: Armchairs are not used in contaminated areas except for offices. Only steel stools or chairs are used.

3. Storage Cabinets: All cabinets shall be of steel construction, with sloping top.

4-10 VESSELS

A. Uses: Vessels are used as shell tanks, caustic or acid tanks, blow-cases, hydrolyzers, mix tanks, fermenters, hold tanks, surge tanks, and receiving tanks and for such services as air, tempered water, refrigerated water, deionized water, etc.

B. Materials of Construction: Vessels may be constructed of stainless or conventional steels, be glass-lined or coated with epoxy resins or made of other materials according to the specific application.

C. Non-Lethal Code Vessels: Non-lethal code vessels shall be designed and constructed as specified in the ASME code.

D. Lethal Code Vessels: Lethal code vessels shall be constructed in accordance with requirements for such service as specified in the ASME code, paragraph UW-2 (all welded construction). Any process vessel which is in contact with any microorganism must be of a material that is non-toxic to the organism. This does not apply to waste treatment vessels. Provisions must be made for isolation and decontamination of lethal vessels.

1. The internal surface of all lethal code vessels, except for waste treatment vessels or others designated by the Government, shall be polished to a No. 4 mill finish or better, and free from irregularities. No back-up rings shall be used in welding.

2. Lethal code vessels may be insulated only over areas that are jacketed.

3. Stainless steel used for lethal code vessels shall be low carbon (304 L, 0.03% maximum carbon) to avoid embrittlement or carbonization at welds. Previously "extra low carbon" was specified, but improved steel making control has made this unnecessary.

E. Design and Testing: All lethal code vessels shall be designed for working pressure plus full vacuum and shall also be designed for internal vacuum. Hydrostatic tests on all lethal code vessels shall be at 1.5 times the design pressure, corrected for the test temperature as outlined in ASME code, paragraph UG-99b. Lethal vessels shall also be halogen leak tested at operating pressure, after installation, as described in 4-18.

4-11 COOLING SYSTEMS

A. Cooling Towers: Cooling towers used for process equipment shall have no piping connections with cooling towers used for air-conditioning chillers. A water meter shall be installed on the makeup line to all cooling towers.

B. Coolers, Heat Exchangers, and Condensers

1. Lethal Code Service: The pressure in an exchanger being used for lethal code service must be such that the fluid side being used for cooling or heating be at a pressure higher than the agent side pressure. This allows the heat transfer fluid to leak into the agent side in case of a break and reduces the danger of contaminating the service fluid.

2. Materials of Construction: Exchangers must be of a material designed to resist corrosion of process liquids as well as decontamination solutions, avoid brittle fracture, provide long life, and be non-toxic to agent material.

3. Maintenance: Heat exchangers, coolers, and condensers shall be designed to allow quick and easy maintenance.

4. Design and Testing: Exchangers used for lethal code service shall be designed and tested in accordance with 4-10 E.

4-12 CENTRIFUGES

A. General: Centrifuges are used to concentrate agent material or used in laboratories for analytical purposes. They include air, electrical, hydraulic, and steam-driven types. The size and capacity will be determined by the specific application. Centrifuge bowls used to contain and concentrate agents shall be constructed of material non-toxic to agents. Centrifuges handling infectious agents must be located in a ventilated enclosure, unless they are equipped with safety cups (see Plate No. 4.12).

B. Free Standing: Laboratory size centrifuges may be free standing floor type or bench top models.

C. Safety Cabinet: A bottom-mounted centrifuge well may be connected to a number of the standard design Class III cabinets for housing the centrifuge. For details of a bottom-mounted centrifuge well see Fort Detrick Drawing No. F-93-1-4007-4.

4-13 PUMPS

A. General: Pumps located in areas subjected to frequent washdowns with decontamination solutions shall be painted to protect against corrosion.

B. Lethal Code Service: Pumps used in transferring concentrated agent slurries shall be of the canned rotor or other Government-approved type, or shall be enclosed in a Class III cabinet. Pumps in contact with agents shall be constructed of a material non-toxic to the agent being pumped, shall be resistant to decontaminating chemicals, and shall be of a sanitary type for ease of dismantling for cleaning purposes.

4-14 HYDRAULIC SYSTEMS

A hydraulic system may be installed as a central system or as an individual local system. Compressed air (CA) may be used as the source of pressure.

4-15 SHAKERS

Shakers handling infectious agents, unless approved safety containers are used, must be located in a ventilated enclosure.

4-16 DECONTAMINATION EQUIPMENT

A. Portable

1. See Appendix B for a discussion of decontaminating agents and methods.

2. Decontamination of equipment and laboratory rooms in contaminated areas will generally be carried out by portable equipment. Overhead sprinkler systems will not be used in laboratory buildings but may be considered for use in pilot plant locations.

B. Installed: See 3-02 S, PIPING.

4-17 SPECIAL EQUIPMENT

A. General: This sub-section covers laboratory and process equipment of less general use or more specialized nature than that covered in the preceding sub-sections. This equipment will generally be specified by the Government in the Contract Scope of Work. Examples of such equipment are:

1. Laboratory Equipment: Balances, sterilizing ovens, conveyors, elevators, etc.

2. Process Equipment: Agitators, pelleters, freeze driers, etc.

384" = 15 psi

5 oz = 1 cu ft = 15 psi absolute

10 oz = 1 cu ft = 15 psi gauge

1 oz = .1 cu ft = 15 psi gauge = 384" H_2O

1 oz = 1 cu ft = 1.5 psi = 38.4" H_2O

.1 oz = 1 cu ft = .15 psi = 3.84" H_2O

3 oz = 1 cu ft = 4.5 psi = 115.2" H_2O

3 oz = 3 cu ft = 1.5 psi = 38.4" H_2O

Mol. wt. Freon 12 (CCl_2F_2) = 114

114 oz occupies 22.7 cu ft.

1 oz " .2 cu ft

5 oz in 1 cu ft = 15 psi = 384" H_2O (absolute)

10 oz in 1 cu ft = 15 psi = 384" H_2O (gauge)

1 oz. = 30 cu ft = .05 psi = 1.28" H_2O

B. Design Considerations

1. Materials of Construction: Equipment shall be fabricated of corrosion-resistant material capable of withstanding a variety of decontaminating solutions. Equipment in contact with agents shall be constructed of material non-toxic to agent material.

2. Finish: All metallic surfaces except stainless steel shall be finished with an acid-, alkali-, and solvent-resistant paint. All exposed stainless steel including the welds shall be ground and polished to either a No. 2B or a No. 4 finish, as specified by the Government.

3. Shaft Seals: See subsection 4-01 E.3f.

4. Anti-Sparking: Consideration should be given to anti-sparking requirements for any area in which powdered material may be present.

5. Special Tests: Performance and reliability tests for equipment may be required, as well as a halogen leak test. See 4-18.

6. Commercial Equipment: Commercially available equipment should be used when it meets the requirements or when it can be suitably modified by specifying different materials of construction, special shop coatings, or other moderate changes.

4-18 HALOGEN LEAK TEST STANDARDS

A. Biological Safety Cabinets

1. Use 1 ounce minimum of Freon-12 (dichlorodifluoromethane) for every 30 cubic feet of enclosure, then apply and maintain 4 inches water gage pressure.

2. In testing for a leak, the nozzle of the probe shall be held at the surface of the unit being tested in such a manner as not to jar the instrument and should be moved at the rate of about ½ inch per second.

3. Ordinarily no leakage should be accepted. In terms of the presently available equipment (General Electric Co. Halogen Leak Detector Model H-2) it is considered that readings up to 0.5 milliampere on the high sensitivity setting are insignificant when testing at 4 inches water gage pressure.

4. The room used for testing must be free of halogen compounds (see also 3-06 B.6, PIPING) and air movements in the room should be kept to a minimum. No smoking should take place in the area in which a test is being conducted.

B. Miscellaneous Equipment: Halogen testing of other equipment shall be carried on at the maximum operating pressure to which the piece of equipment will be subjected.

4-19 INSULATION

A. Insulation that liberates halogens shall not be used on mechanical equipment if there is any danger that the insulation will interfere with halogen leak-testing of adjacent safety cabinets or other gastight equipment. Such danger may be absent because:

1. The insulated equipment is sufficiently removed from the cabinets.

2. The construction of the insulated equipment effectively seals the insulation from the atmosphere.

B. See also 3-06, PIPING.

4-20 FORT DETRICK DESIGN PRACTICES

A. Scope

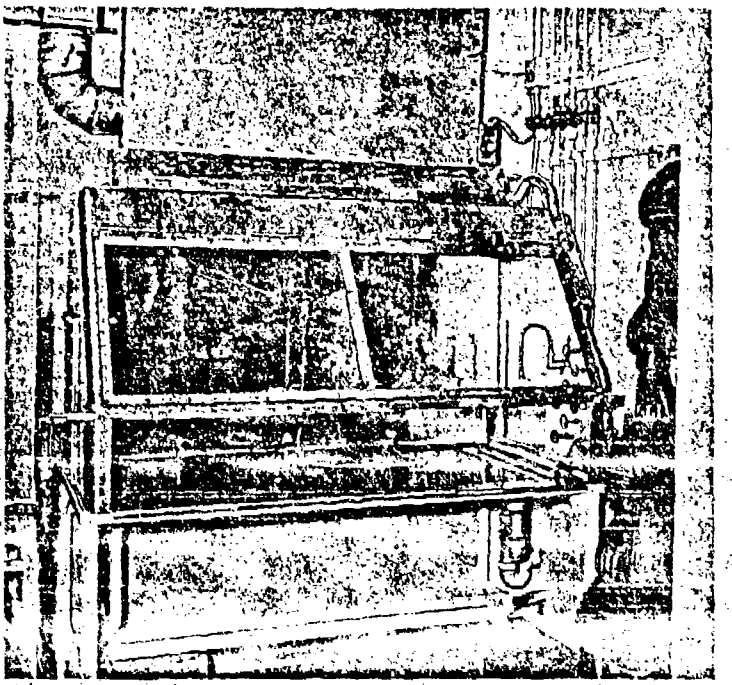
1. This subsection contains criteria and design information not related to biological safety considerations, and is not intended to be comprehensive.

B. Sterilizers

Sterilizers are normally used in the following sizes:

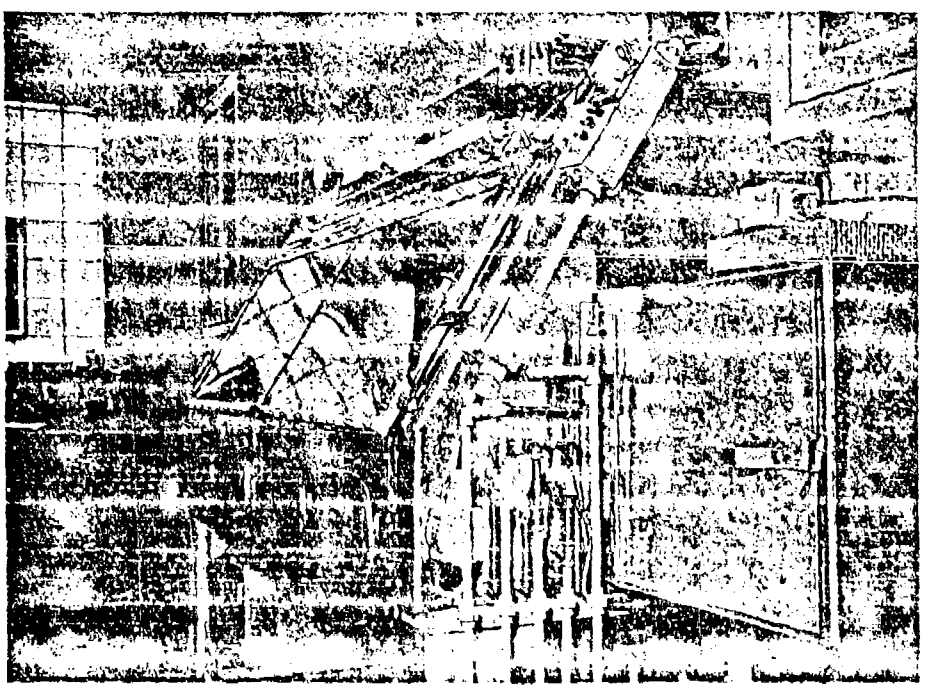
Inside Dimensions	Approximate Inside Volume, cu. ft.	Application
16" wide x 16" high x 24" long	3.6	Gas sterilizers between contaminated and non-contaminated offices. In laboratories and for attachment to biological safety cabinets Class I and Class III
20" wide x 20" high x 36" long		In laboratories and for attachment to biological safety cabinets Class I and Class III
24" wide x 24" high x 36" long	12	In glassware washing rooms
24" wide x 36" high x 48" long	24	In ventilated suit and [illegible] holding units; gas sterilizers between non-contaminated and contaminated storage rooms; in media preparation and glassware washing rooms

Inside Dimensions	Approximate Inside Volume, cu. ft.	Application
36" wide x 42" high x 84" long	74	For ordinary loads of cages and between non-contaminated and contaminated storage rooms
48" wide x 54" high x 84" long	126	For heavy loads of cages



Class I Safety Cabinet, Front Open

PLATE NO. 4.1



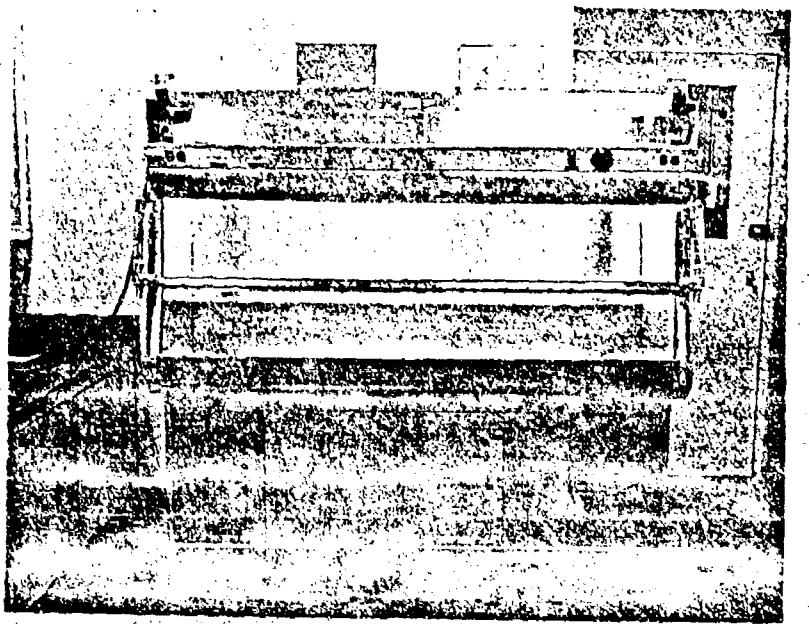
Class I Safety Cabinet, Front Closed

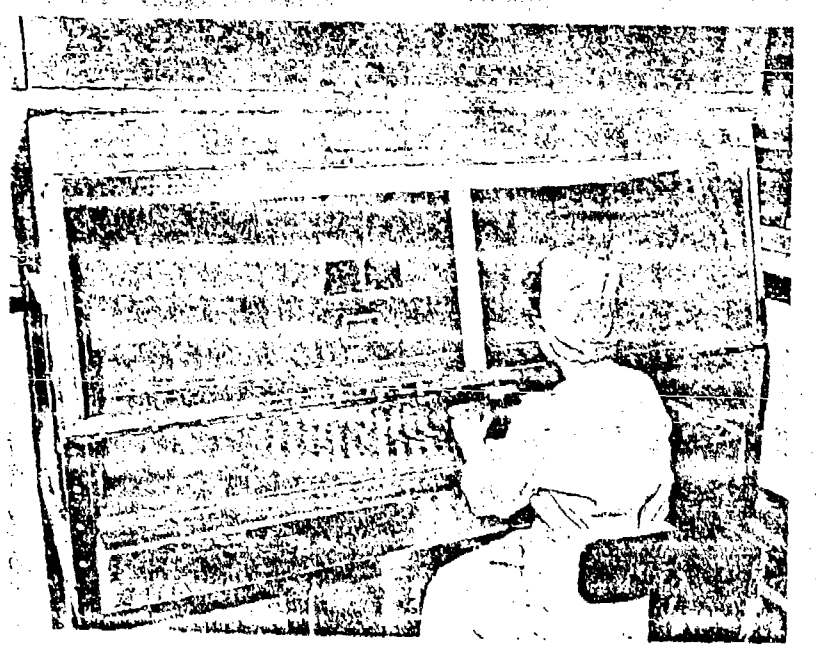
PLATE NO. 4.2

PHOTOGRAPH OF LAMINAR AIRFLOW CABINET

REV	DATE

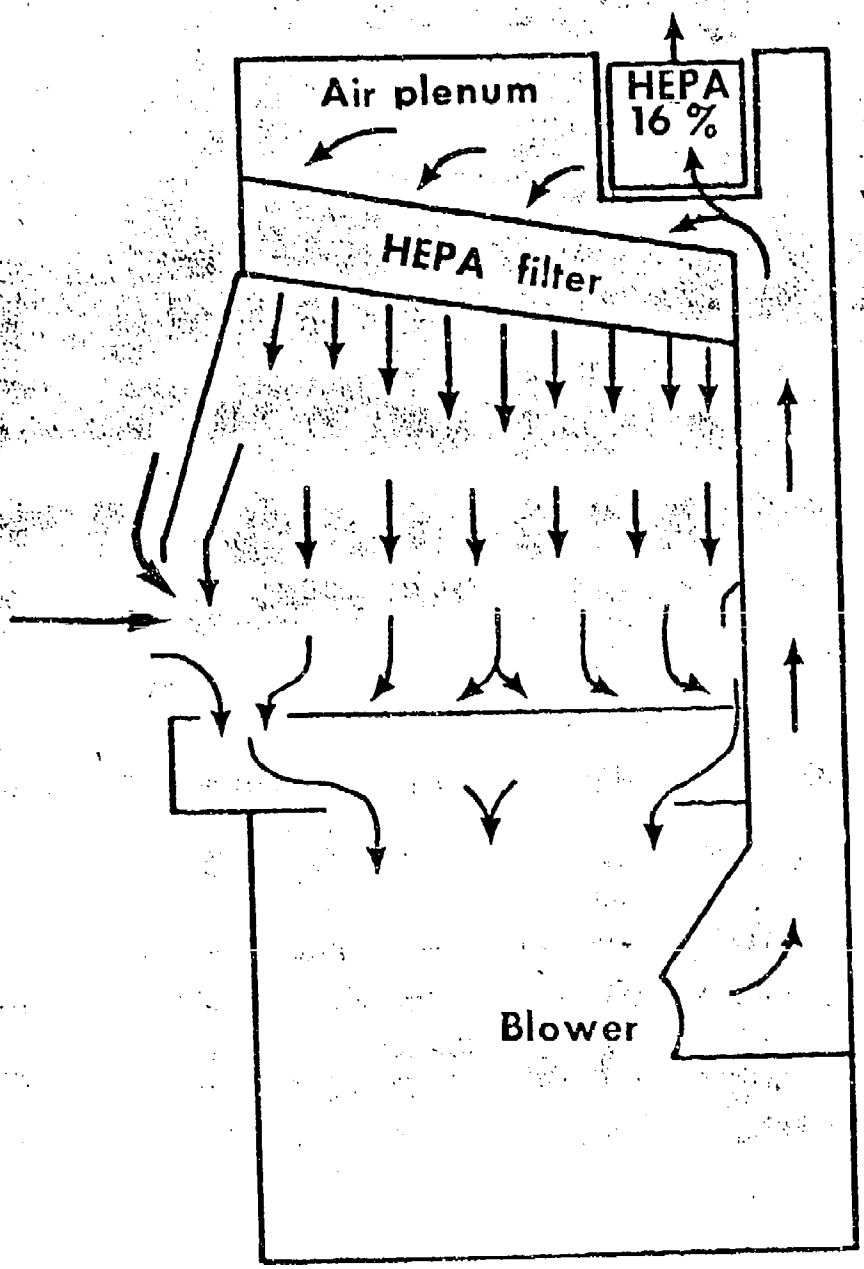
DATE-1 DEC 69 | PLATE NO. 4.2 A





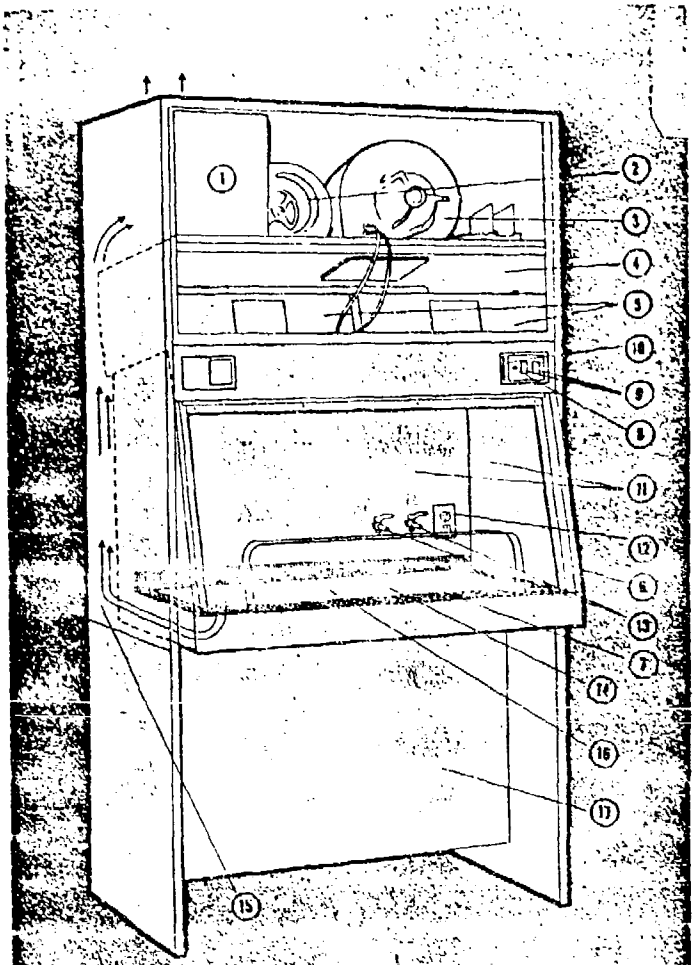
PHOTOGRAPH OF LAMINAR AIRFLOW CABINET	REV	DATE	DESCRIPTION
		DATE-1 DEC 69	PLATE NO. 4.2B

BIO-HAZARD HOOD — BAKER COMPANY



AIRFLOW PATTERN IN LAMINAR AIRFLOW CABINET	REV	DATE	DESCRIPTION
		DATE-1 DEC 69	PLATE NO. 4.2C

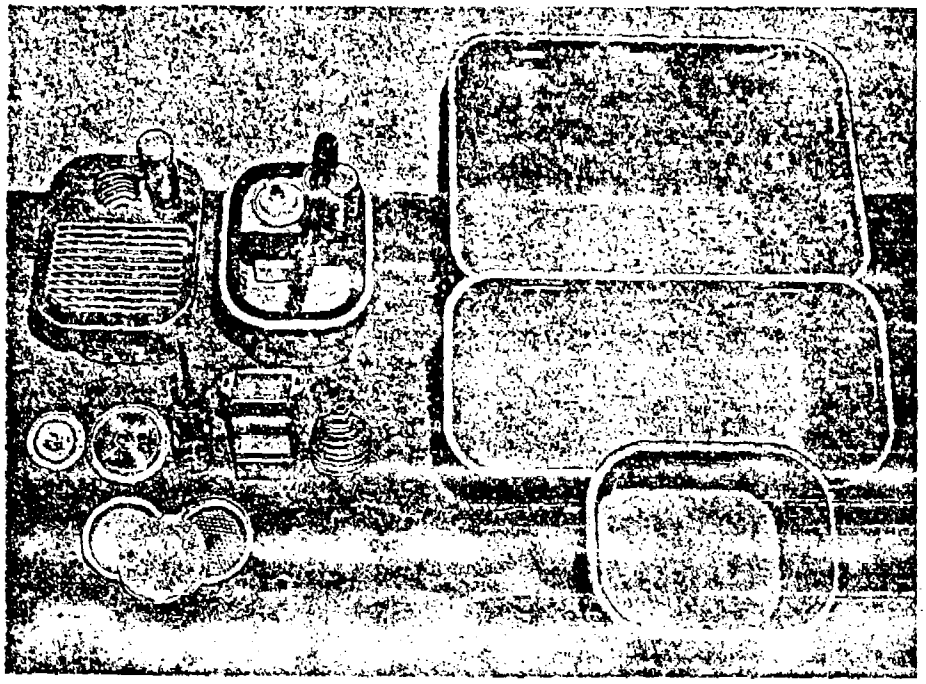
4/70



1. Exhaust HEPA filter
2. Exhaust Blower
3. Supply Blower
4. Supply Plenum
5. Supply HEPA filters
6. Polycarbonate View Screen (Air Curtain)
7. Front Return Grill
8. Air Velocity Control
9. Control Switches
10. Air Velocity Indicator
11. Stainless Steel Interior Sides
12. 120 Volt AC Duplex Outlet
13. Gas, Air/Vacuum Fixtures
14. Rear Return Grill
15. Return Plenum
16. Solid Work Surface
17. Base Support

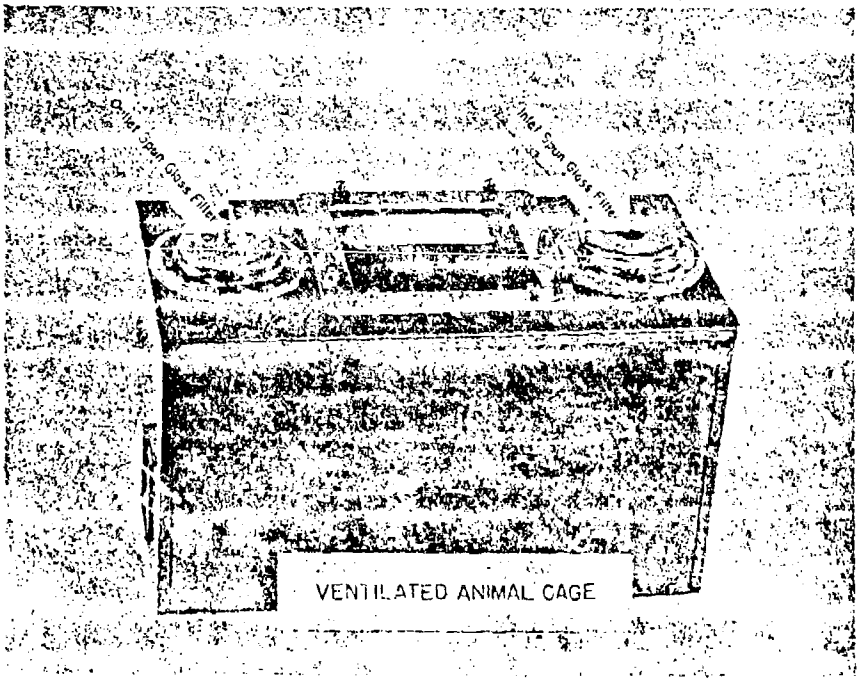
COMPONENTS OF TYPICAL
LAMINAR AIRFLOW CABINET

REV	DATE	DESCRIPTION
	DATE-1 DEC. 69	PLATE NO. 4.2D



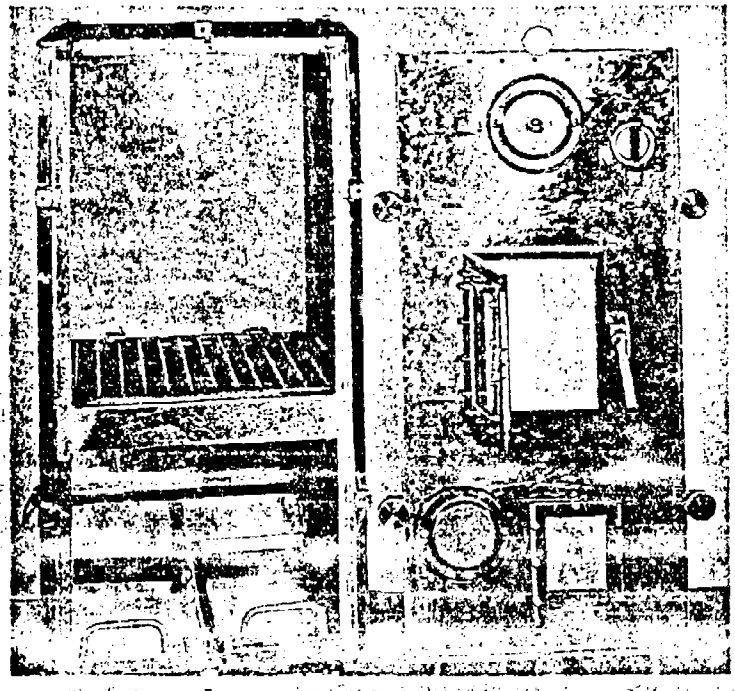
Small Animal Cages; (1) Unventilated (left); (2) Ventilated (center); Showing Components and Several Other Cage Sizes

PLATE NO. 4.4

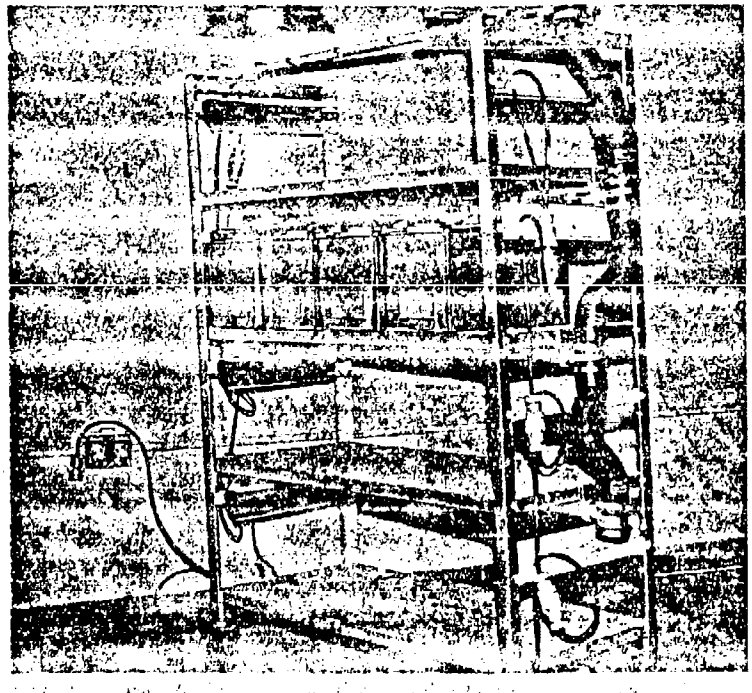


Ventilated Animal Cage

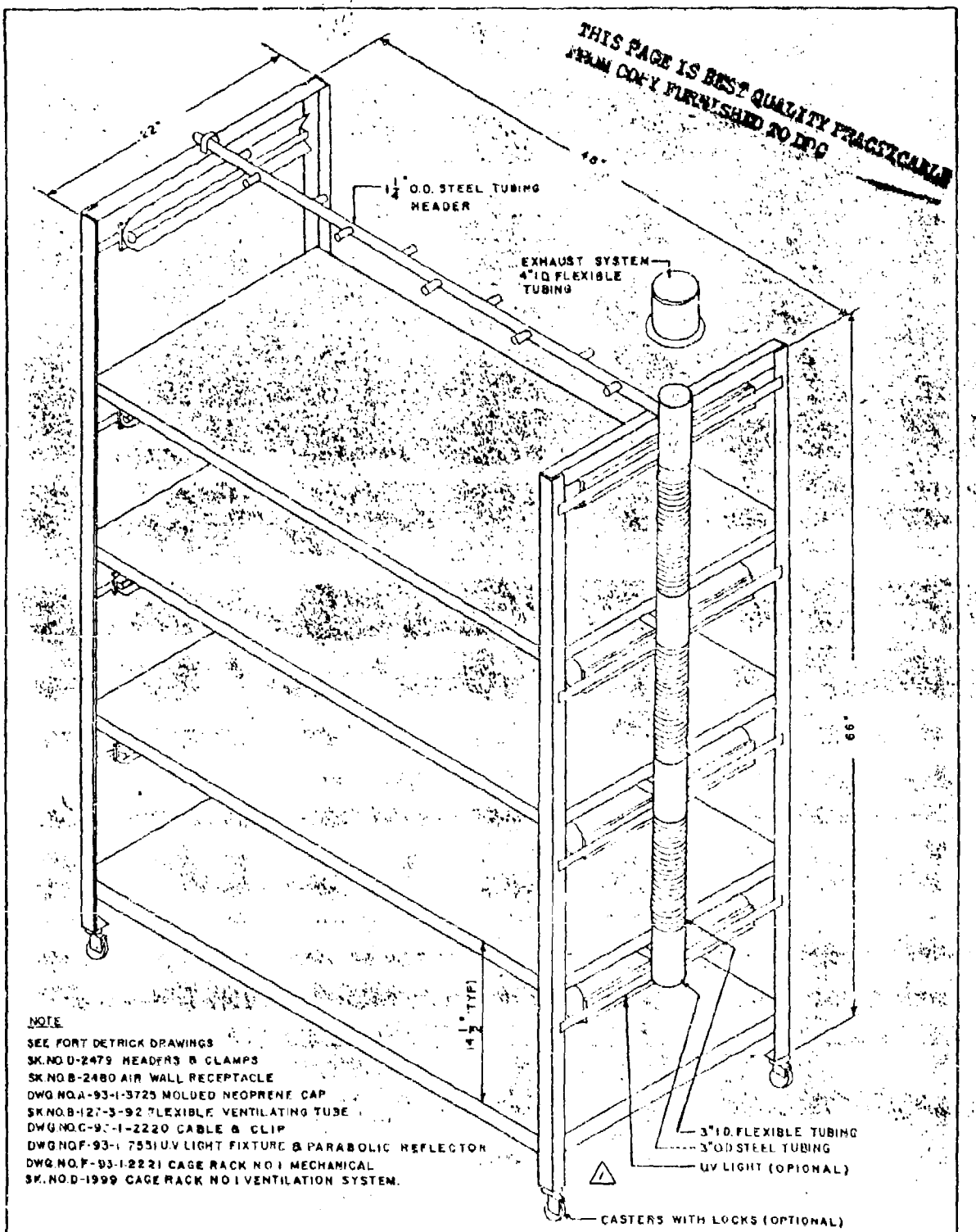
PLATE NO. 4.5



Ventilated Monkey Cage with Door Removed	PLATE NO. 4.6



Ventilated Cage Rack Equipped with U.V.	PLATE NO. 4.7



NOTE

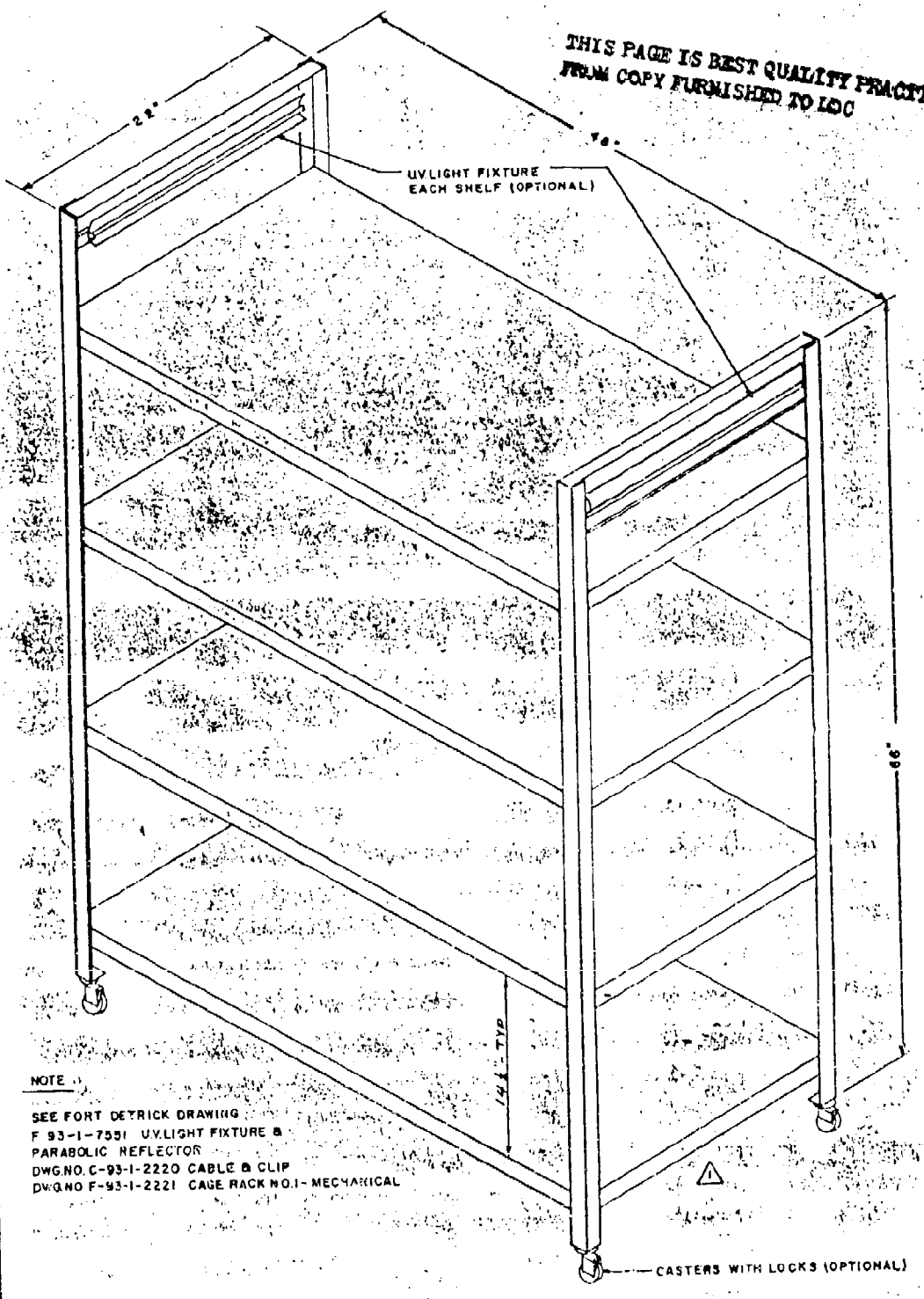
SEE FORT DETRICK DRAWINGS
SK. NO. D-2479 HEADERS & CLAMPS
SK. NO. B-2480 AIR WALL RECEPTACLE
DWG. NO. A-93-1-3725 MOLDED NEOPRENE CAP
SK. NO. B-127-3-92 FLEXIBLE VENTILATING TUBE
DWG. NO. C-93-1-2220 CABLE & CLIP
DWG. NO. F-93-1-7551 U.V. LIGHT FIXTURE & PARABOLIC REFLECTOR
DWG. NO. F-93-1-2221 CAGE RACK NO. 1 MECHANICAL
SK. NO. D-1999 CAGE RACK NO. 1 VENTILATION SYSTEM.

VENTILATED CAGE RACK

REV.	DATE	DESCRIPTION
1	AUG 61	GENERAL REVISION

DATE - 1 FEB 60 | PLATE NO. 4.8

3/68



NOTE

SEE FORT DETRICK DRAWING
F 93-1-7551 UV LIGHT FIXTURE & PARABOLIC REFLECTOR
DWG NO. C-93-1-2220 CABLE & CLIP
DWG NO F-93-1-2221 CAGE RACK NO.1 - MECHANICAL

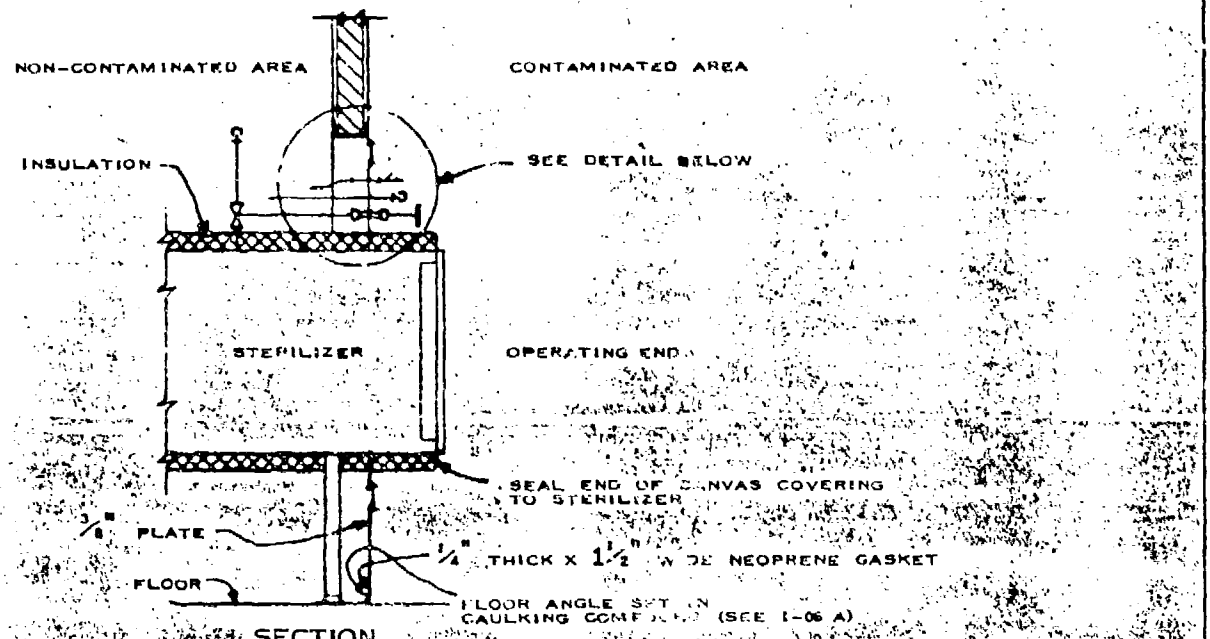
REV.	DATE	DESCRIPTION
1	AUG 67	GENERAL REVISON

NON-VENTILATED CAGE RACK

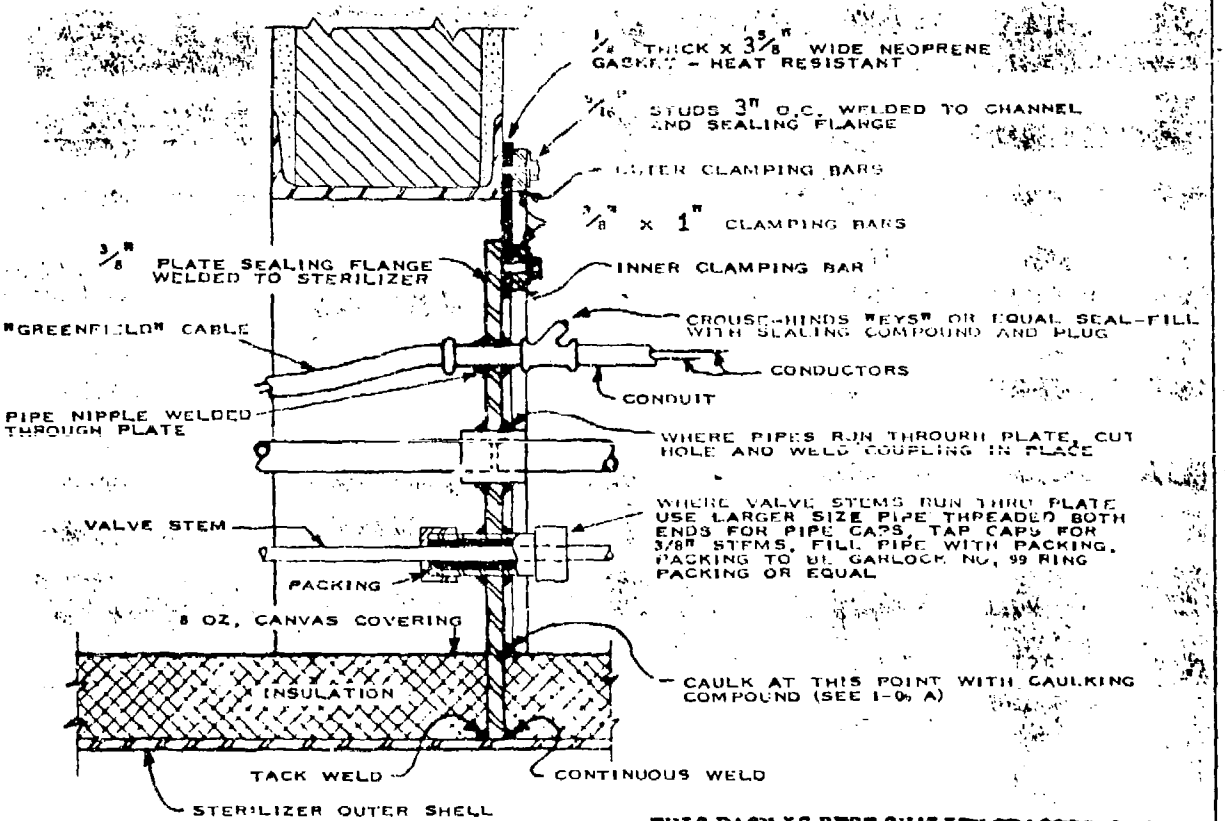
DATE - 1 FEB 66

PLATE NO 4.9

3/68



SECTION



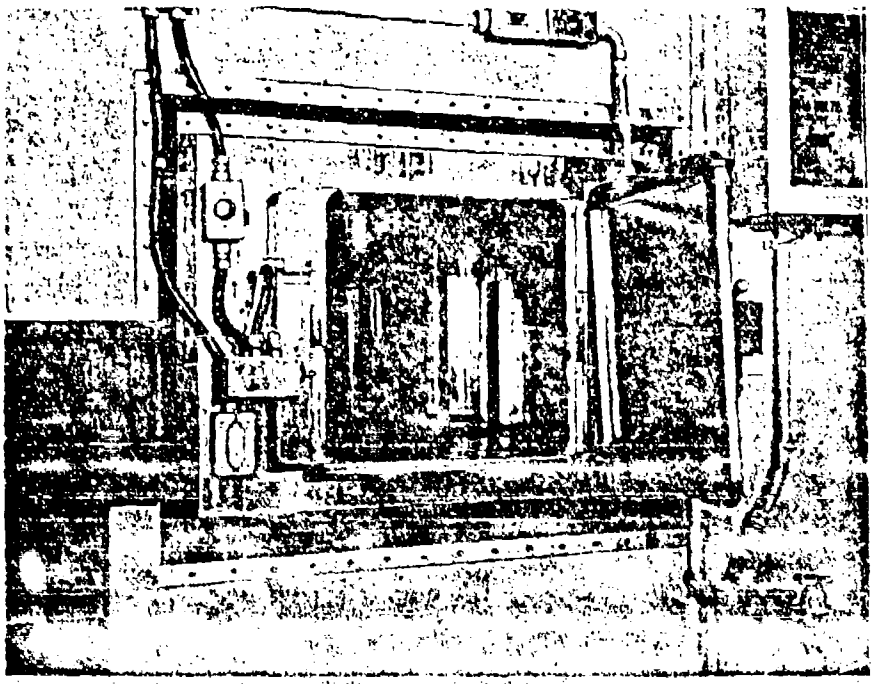
DETAIL

METHOD OF SEALING STERILIZERS EXTENDING THROUGH WALLS

REV.	DATE	DESCRIPTION

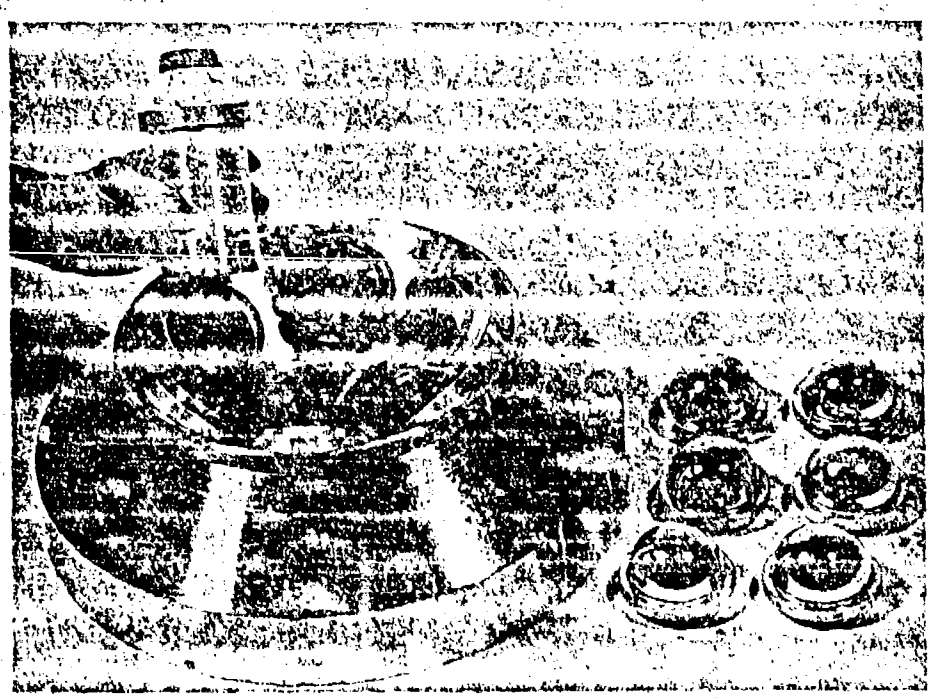
DATE - 1 FEB. 66

PLATE NO. 4.10



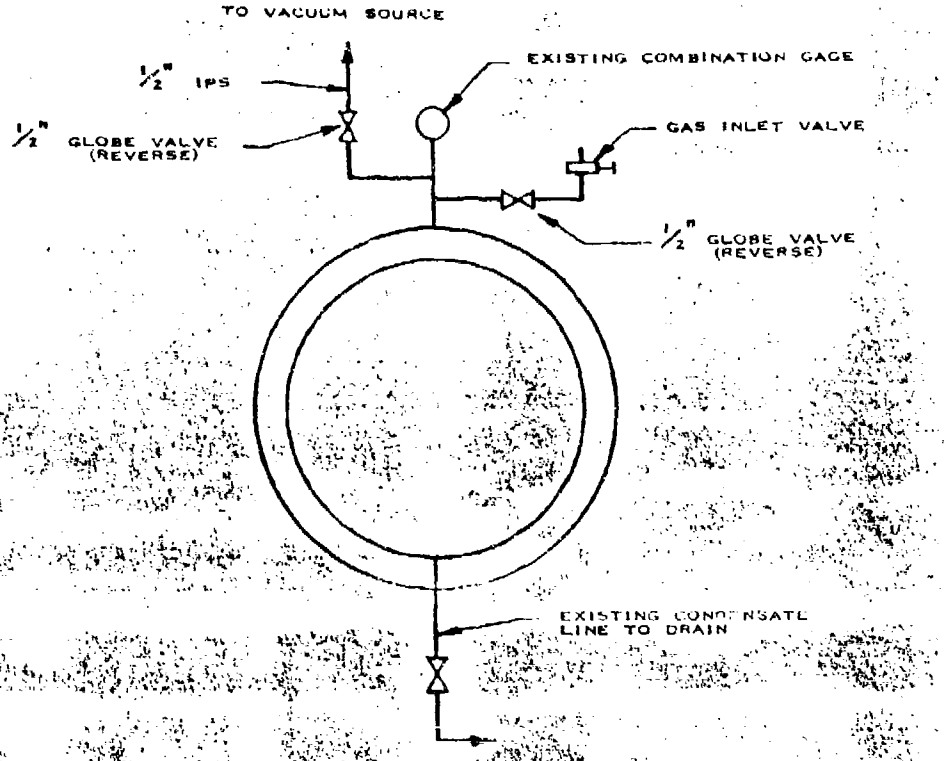
Wall Seal Around Pass-Through Lock

PLATE NO. 4.11



Safety Centrifuge Cups

PLATE NO. 4.12



NOTE

BAFFLE IS REQUIRED TO DISPERSE FREON-ETHYLENE OXIDE MIXTURE WHEN GAS IS ADMITTED DIRECTLY INTO CHAMBER

TYPICAL PIPING REQUIRED TO ADAPT STEAM STERILIZERS TO GAS	REV.	DATE	DESCRIPTION
	DATE - 1 FEB. 66		PLATE NO. 4.13

SECTION 5 - ELECTRICAL

TABLE OF CONTENTS

Page No.

LIST OF PLATES

SECTION 5

ELECTRICAL

5-00 INTRODUCTION

A. Scope

This section is addressed primarily to those architect-engineering personnel concerned specifically with the electrical engineering and design to microbiological facilities at Fort Detrick. It applies to new facilities, and to modifications and additions to existing facilities.

We repeat here again, as in every section, that the purpose of this manual is to present special design criteria based primarily on biological safety considerations. It is not intended to duplicate the fund of standards and criteria normally possessed by the architect-engineer. However, a sub-section of Fort Detrick Design Practices not related to safety considerations is given at the end of this section. In addition, Appendix A lists a number of Fort Detrick Purchase Descriptions and Specifications.

As described in Volume I, Fort Detrick contains a variety of facilities, such as laboratories, pilot plants, test chambers, filling lines, storage areas, and others. This manual presents the criteria that all of these facilities have in common. To avoid vagueness, many of the criteria are stated in terms of laboratory buildings, but this should not be taken to mean that they are not generally applicable.

With some exceptions, the requirements peculiar to each type of facility are not covered in this manual.

B. Conversions and Modifications

The application of the criteria presented here to the design of new facilities generally will be straightforward. However, many projects involve the conversion or modification of existing facilities. Since these facilities were built there have been changes in the criteria, based on technical innovations or operating experience. As a result, it is important for the designer of such modifications to exercise judgment and flexibility in applying the new criteria. Some of the potential problems will be resolved by the specific Contract Scope of Work for the individual project or by other guidance provided by the Government.

C. Organization of Section 5

The remainder of this section is divided into a large number of sub-sections. However, most of the special criteria arising from microbiological safety considerations will be found in the areas of lighting, ultraviolet applications, laboratory equipment, and miscellaneous

electrical specialties. The relatively large sub-section at the end of Section 5 is concerned with Fort Detrick Design Practices not related to safety.

5-01 POWER DISTRIBUTION

A. See 5-14, Fort Detrick Design Practices.

5-02 POWER AND LIGHTING

A. Distribution Panels: Separate power and lighting distribution panels shall be provided for contaminated and non-contaminated areas.

B. Conduit and Wiring

1. Conduit shall be of the rigid steel hot-dipped galvanized or sherardized type, but only one type shall be used in any given building.

2. Conduit in contaminated areas shall be run exposed.

3. To prevent the spread of infectious agents through openings, conduit passing through the wall and/or floor from a contaminated area to a non-contaminated area, or between areas of different levels of contamination shall be sealed on the contaminated side. In no case shall the sealing fitting be farther than 18 inches from the divisional point, and there shall be no other fittings between the sealing fitting and the divisional point. Sealing fittings shall be type EYS or EZS using 3M #PC-1120 E.C. compound and shall be gastight. Sealing around conduits shall be done in accordance with details shown on Plates No. 1.16, 1.17, 1.19, and 1.20. All seals shall be installed at a location readily accessible for inspection and maintenance.

a. See also 1-03, ARCHITECTURAL.

4. To avoid crevices that might permit buildup of contamination, and to promote ease of painting and cleaning, conduit should never be mounted directly against a wall or ceiling.

a. Plate No. 3.2 indicates required spacing between conduit and wall, between adjacent conduits, and method of support, including the use of caulking compound to fill irregularities.

b. Where surface-mounted outlet boxes are used, a biological sealing compound (see 1-06 A, ARCHITECTURAL) shall be used for filling joints between boxes and wall surface.

C. Lighting: Accepted Levels of Illumination

1. See 5-14 F, Fort Detrick Design Practices.

D. Lighting Fixtures

1. Fluorescent lighting shall be provided throughout all buildings, except where vapor-tightness or other special requirements must be met, as specified below. Fluorescent lights shall be the commercial type with louvers or lenses.

2. Recessed fixtures shall not be installed in contaminated areas. If surface-mounted lighting has to be used, a biological sealing compound shall be used for filling joints between fixture and ceiling surface.

3. Light fixtures and all wiring components including outlets, switches, and receptacles installed in areas of "high humidity" shall be vapor-proof. Conduits to walk-in refrigerators and incubators shall be sealed in accordance with the National Electric Code Article 300-6 (a).

4. Suitable waterproof fixtures shall be provided in all animal rooms and elsewhere where routine operations require washing walls and ceilings.

5. See also 5-14 F, Fort Detrick Design Practices.

6. One unswitched fluorescent light shall be provided at each vault area.

7. One-third of the attic, utility area, and basement lights shall be unswitched and fed directly from panel breakers.

E. Receptacles

1. All areas (both contaminated and non-contaminated) shall have convenience outlets, which shall be duplex parallel blade, 3-wire, U-ground, 115-volt, 20-ampere, specification grade.

2. No floor-type convenience outlets shall be installed in contaminated areas.

3. At least one 2-gang, water-tight 115-v a.c. outlet is required in each walk-in incubator and refrigerator to supply power for shakers, stirrers, and motors. A cut-off switch and red pilot shall be provided outside the refrigerator or incubator on a nearby wall, properly labeled, for all such electrical outlets.

4. At least one 208-v, 2-wire polarized outlet shall be installed in each laboratory.

F. Grounding

1. For special process equipment specific instructions will be issued where required.

2. For general grounding provisions, see 5-14 G, Fort Detrick Design Practices.

5-03 ULTRAVIOLET REQUIREMENTS

A. General: In certain specific applications, germicidal ultraviolet (U.V.) radiation is an effective means of decontaminating air and surfaces. However, U.V. radiation has no penetrating power, and effective use of U.V. requires an exact understanding of its limitations. Proper intensity, exposure time, and maintenance of equipment are critical. (See Appendix B for discussion of decontamination methods.)

B. U.V. Applications

1. Personnel air locks shall have U.V. door barriers at the contaminated end preferably inside the airlock, and U.V. ceiling-mounted or suspended fixtures inside, as illustrated on Plates No. 1.6, 1.7, 1.8, and 5.1 (see also 1-01 E, ARCHITECTURAL).

2. Elevators shall have U.V. barriers installed in the shaft at all landings. In the event of bi-parting elevator doors, the horizontal overhead fixture may be omitted from the barrier.

3. Dumbwaiters shall have wall mounted U.V. installations over the service openings; and these shall be shielded by "Alzak" aluminum reflectors, or approved equal, to protect personnel and to concentrate the irradiation down over the opening.

4. Contaminated change rooms shall have a U.V. air lock between the contaminated and non-contaminated areas.

a. For U.V. shoe rack and discarded clothing rack, see 1-01 D, ARCHITECTURAL and Plates No. 1.3, 1.4 and 1.5.

5. Walk-in refrigerators and incubators shall have U.V. ceiling units for direct irradiation. Walk-in refrigerators shall have watertight U.V. fixtures.

6. Some laboratories will require U.V. ceiling installations, when specified by the Government.

7. Passages between contaminated areas may have, in addition to door barriers, U.V. ceiling units to aid in controlling the passage of infectious agents.

8. For use of U.V. chambers for paper pass-through, etc. see 1-02 B.4, ARCHITECTURAL.

9. Laboratory equipment such as Class I and Class III cabinets may require built-in U.V. installations (see 5-04).

C. Approved U.V. Components

1. To reduce stray radiation hazard to personnel, protective louvers are required on all fixtures mounted in door barriers and at other locations specified by the Government (see Fort Detrick Drawing F-93-1-7651 and Plate 5.1).

2. Generally, cold cathode type germicidal lamps are preferred because of their greater life and resultant economy. Hot cathode lamps shall be used only where space limitations for U.V. fixtures are imposed by equipment design.

3. Cold cathode watertight fixtures shall conform to Fort Detrick Drawing F-93-1-7651.

4. U.V. fixtures of the hot cathode type installed in safety cabinets and on animal cage racks shall be the fixture shown on Fort Detrick Drawing F-93-1-7551.

5. See also 5-14 H, Fort Detrick Design Practices.

D. U.V. Installation Specifications

1. Each U.V. installation shall have a separate local switch and a 1½-inch-diameter blue jeweled warning light mounted with switch plate distinct from other lighting switch plates.

2. Door barrier switches and warning lights shall be mounted according to Plate 1.6.

3. Caution signs will be furnished and installed by the Government at appropriate and conspicuous places at each U.V. installation.

4. The design of ultraviolet installations will be reviewed by the Government for adequacy and safety. Field tests with mock-up installations may be required prior to acceptance of new designs.

5. Ultraviolet (cold cathode type) barrier shall be installed around the door in the air lock at the contaminated side (see Type A and B air locks, Plates 1.6 and 5.1). The ultraviolet door barrier shall utilize Westinghouse cold cathode fixtures, type SB-30, or the watertight cold cathode fixture shown on Fort Detrick drawing F-93-1-7651, either one complete with "Alzak" reflectors and louvers shown on the same set of drawings. Cold cathode tubes shall be Westinghouse type, 782L-30, or approved equal. Door barriers shall be protected by a continuous metal shield capable of withstanding damage from carts, fabricated preferably from sheet steel, finished on the interior with aluminum paint, sized to contain the necessary quantity of U.V. fixtures, and securely fastened to the wall. The ultraviolet source should be placed back from the door opening edge to assure cut-off of stray irradiation. Stray irradiation shall not exceed the boundary over 2 feet beyond either side of the door on the centerline of door opening.

A total flux of 250 microwatts per sq. cm. at the point three (3) feet above the floor level in the center of the doorway is required. The total flux is obtained by adding the intensities falling upon a surface from three (3) directions: from above, from the left side, and from the right side.

6. Ultraviolet (cold cathode type) inside the air lock shall be mounted overhead. The fixture shall be the same as specified in paragraph 5-03 D.5. For ceilings of 8 to 9½ feet in height, fixtures shall be mounted on the ceiling irradiating downward. For ceilings over 9½ feet high, the fixtures shall be hung back-to-back eight (8) feet from floor level. For air locks not over 12 feet long, one ceiling mounted or one back-to-back unit shall be installed for each 30 to 40 square feet of floor area. Air locks over 12 feet long shall have one U.V. ceiling unit for each 40 to 50 square feet of floor area.

7. Bare ultraviolet to irradiate the whole room shall be installed in walk-in refrigerators and incubators in infectious units, with an outside control and warning light. The material requirements are the same as for airlocks. For refrigerators and incubators with less than 50 square feet area, use one cold cathode lamp and for 50 to 200 square feet area, use two cold cathode lamps. Fixtures shall be ceiling mounted and located to satisfy the following conditions:

a. Each lamp shall be at least 2 feet away from the nearest storage shelf.

b. Fixtures shall be placed so that cold or warm air from blowers does not strike the lamps. If necessary, shields may be installed to protect the lamp.

8. Bare ultraviolet is suggested for some laboratories where it is especially desirable to control non-specific molds and bacteria; e.g. where bacterial agar plating is performed. Outside control and warning light shall be used. The material requirements are the same as for airlocks, except that, in certain cases, reflectors may be desired. One back-to-back double fixture shall be installed for each 75 to 100 square feet of floor area. Special rooms such as sterile media preparation rooms may require additional fixtures.

9. Many special uses for ultraviolet radiation in bacteriological laboratories are conceivable. Each use will necessitate special consideration as to design of installation, type of bulb and intensities required. Drawings, or information from the drawings, of specialized equipment requiring U.V. can be made available to the contractor by the Government. A listing of special laboratory equipment electrical requirements including U.V. follows in 5-04. All U.V. installations are subject to review and approval of the Government.

5-04 LABORATORY EQUIPMENT

A. Electrical Requirements of Specialized Equipment

1. Biological safety cabinets Class I and laminar airflow require 115-v services. A separate circuit is required for each of the following: fluorescent lights, U.V. lights, and receptacle.

2. Biological safety cabinet, Class III: same as Class I and laminar airflow requirements, except that requirement for U.V. shall be at the option of the Government.

3. Autopsy cabinet: same as Class I and laminar airflow.

4. Cage service cabinet: same as Class I and laminar airflow.

5. Radiological hood: requires 115-v services, a separate circuit for the light and built-in receptacle, and a separate circuit for the fan motor.

6. Steam-heated sterilizer: requires 115-v service at the sterilizer for control.

7. Animal cage rack: Plates 4.7 and 4.9, require watertight duplex wall outlets for U.V.

8. Electric air incinerators for exhaust air decontamination: may have a 15- to 20-kw load, and shall be designed for 440-v, 3-phase operation.

9. Transfer air lock: requires 115-v service for one 15-watt U.V. lamp.

10. Fume hood: requires 115-v service for lights, and in some cases requires 115-v or 208-v service for fan motors, all to be explosion-proof.

11. U.V. chamber: for sterilization of papers, small items, etc. requires 115-v service. See Fort Detrick Drawing F-93-1-6714.

B. Safety Cabinet Wiring: MI cable shall be used for wiring into and inside safety cabinets, to prevent leakage back through the cable.

1. Design of the electrical penetration is covered in the "Biological Safety Cabinets" catalog, see 4-01 F.2, EQUIPMENT.

C. In design or modification to existing buildings, installed voltage characteristics shall govern voltage selections.

D. See also 5-14, Fort Detrick Design Practices.

5-05 MISCELLANEOUS ELECTRICAL SPECIALTIES

A. Heating and Ventilating

1. The building air supply fans for contaminated areas shall be inter-

locked with the exhaust fans, so that when the exhaust fans fail, the supply fans will be automatically shut down. See also 2-11, HV&AC.

2. For exhaust fan shut-off switch, see 5-08 D.4.

B. Piping: Solenoid valves, float switches, and pressure switches in process work shall be provided for 115 volts.

C. Electrical

1. Household type refrigerators shll have the interior light switch and thermostat removed and the controls mounted outside the refrigerator.

2. Electric clock outlets shall be provided in contaminated corridors but in no other caontaminated areas.

D. See also 5-14, Fort Detrick Design Practices.

5-06 EXPLOSION-PROOF AREAS, HAZARDOUS LOCATION

A. Conductive Flooring: In contaminated area, see 1-05 C.7, ARCHITECTURAL.

B. General Requirements: See 5-14 K, Fort Detrick Design Practices.

C. Dry Powders: The handling of dry powders in pilot plant work, munitions filling, etc. may introduce the need for special grounding methods on specialized equipment. Guidance will be provided by the Government.

5-07 STANDBY ELECTRICAL SERVICES

A. Emergency Lighting

1. Type: Units shall be of the wet battery, sealbeam flood type.

2. Starting and Duration

a. Units shall provide instant light when power fails.

b. Duration shall be one hour minimum.

3. Location: Lighting shall be provided in the following locations:

a. Corridors.

b. Stairways.

c. Attics, basements, and other equipment rooms.

d. Other as directed.

B. Emergency Power

1. Starting and Duration

a. Emergency power shall start within 2 minutes of failure.

b. Duration shall be 36 hours minimum.

c. Exception: see 5-14 L.2a, Fire Detection and Alarm System.

2. Location

a. All animal rooms with ventilated cages will require emergency power within 15 minutes for cage ventilation.

b. Some refrigerators, incubators, and special equipment as specified by the Government.

c. Sump pump in basement.

d. Provide emergency power for 20% of all corridor, stairway, and change area lights.

3. Automatic Timers: All 440-volt, 3-phase, non-automatic starting equipment shall be re-started after power interruption in sequence, by means of cyclic timers.

5-08 FIRE DETECTION AND ALARM SYSTEM

A. Criteria for Use. See 3-05 D, PIPING and AR 420-90, Change 1.

B. Signal Transmitters: See 5-14 L.2, Fort Detrick Design Practices.

C. Detection Devices: All fire detector thermostats shall be of a fixed temperature or a combination fixed temperature rate-of-rise type, and shall be of a type listed for use in hazardous locations (Class I and Class II), such as "Detect-a-Fire" Type 7020, manufactured by Fenwal, Inc. or approved equal. Care shall be taken to avoid placing the thermostats over sterilizers or other hot spots unless the thermostat is set at a higher temperature.

D. Ventilation and Alarm Controls

1. Connections to the fire alarm in the central firehouse will be made by the Government.

2. A suitable number of alarms shall be installed throughout each building. Generally, 8-inch vibrating bells shall be installed in corridors. Four-inch or 6-inch bells may be used in smaller spaces separated from main areas, such as attics and utility rooms.

4/70

3. A key operated switch shall be provided to silence all building fire alarm bells and shall be located adjacent to the fire alarm control panel.

4. A switch to shut off the building ventilation exhaust fans in case of fire shall be mounted outside the building, usually near the utility room exterior entrance. The switch shall be enclosed in a weatherproof metal box, painted red, and shall operate a relay with normally closed contracts.

a. See also 2-11, HV&AC.

E. Specifications for Installation

1. Conduit shall be installed in accordance with 5-02 B.

2. See also 5-14 L.3, Fort Detrick Design Practices.

F. Fire Sprinklers: See 3-05, PIPING.

5-09 OTHER ALARM SYSTEMS

A. Biological Spill Alarm System

1. General: The biological spill alarm system is provided in large laboratory buildings to keep personnel away from the contaminated area until the spill has been cleaned up.

2. Detection: The alarm is initiated by manual push-buttons which actuate (separately) a coded tone signal and a light.

3. Zoning: The building is divided into a number of zones, each equipped with a number of push-buttons connected to the warning horns. Any push-button actuates all the horns with the coded signal for the given zone. There are a number of lights in each zone, each separately actuated by its own manual switch to localize the spill indication.

4. Conduit: Conduit shall be installed in accordance with 5-02 B.

B. Post-Wide Alarm System

1. Triggering Conditions: The post-wide alarm system consists of supervisory devices to detect off-normal operation of various types. It is triggered when the following conditions occur:

a. Power failure.

b. Flame failure.

c. Pressure failure.

d. Explosive or toxic gas hazards.

e. Temperature failure.

f. Flow failure.

g. Conductivity failure.

h. Motion failure.

i. Light transmission low or high.

j. Level high or low.

k. Supervise any type of operation in: Process, laboratory, or in any building on post.

2. Circuits: The above devices shall be wired directly into either single or combined circuits. Circuits shall be 110 V 60 cycle single phase and be connected into either normally energized or deenergized devices as the conditions demand at time of design. These devices are connected to local annunciator panel.

3. Local Annunciator Panel: An annunciator panel shall be installed in an accessible location in each building. It shall be 110 V 60 cycle and designed to specifications of existing equipment (Panellit Model 50). All relays shall be hermetically sealed, and designed to work in the existing integrated system. This annunciator shall include local alarm (horn or buzzer 110 V 60 cycle).

4. Tie-In to System: The annunciator panel shall be supplied with a set of auxiliary contacts and these in turn connected to the cable of the post-wide alarm system, which is connected to a central annunciator panel in the waste decontamination plant. Suitable lightning arrestors and proper grounding procedures shall be observed, as in telephone work.

5. Conduit: Conduit shall be installed in accordance with 5-02 B.

C. Security Alarm System: No requirements, unless requested by the Government.

5-10 CLOSED-CIRCUIT TELEVISION SYSTEM

A. General: A closed-circuit television system may be required to permit viewing of contaminated area from non-contaminated areas.

B. Scope: The contractor shall provide a conduit system, complete with terminal cabinets and outlet boxes. Wiring and connectors will be provided and installed by the Government.

C. Outlet Locations

1. Contaminated and non-contaminated conference rooms, to permit joint conference.

2. Others as specified.

D. Design Requirements

1. Conduit shall be installed in accordance with 5-02 B.

2. See also 5-14 M.2, Fort Detrick Design Practices.

5-11 TELEPHONE SYSTEMS

A. Scope: The contractor shall provide only a telephone conduit system, with fishwire, complete with terminal cabinets, necessary pull-boxes, and outlet boxes. Instrumentation and wiring will be provided by the Government.

B. Required Locations: At least one (1) telephone capable of making and receiving off-post calls shall be installed in each major contaminated corridor and one in each main office in the contaminated area on each floor of the building.

C. Other Design Requirements

1. Conduit shall be installed in accordance with 5-02 B

2. See also 5-14 N.2, Fort Detrick Design Practices.

5-12 INTERCOMMUNICATION

A. General: Intercommunication systems are provided to permit communication between the non-contaminated office and contaminated areas, between personnel in ventilated suits and other personnel, and for public address.

B. Scope: The contractor shall provide an intercommunication circuit system, complete with terminal cabinets and outlet boxes, similar to the telephone system described in sub-section 5-11, but also including wiring and instruments.

C. Outlet Locations: As specified by the Government, with consideration for future requirements.

D. Design Requirements

1. Master stations shall be intercommunicating.

2. Conduit shall be installed in accordance with 5-02 B.

3. Outlets for ventilated suit communication shall be provided as specified by the Government.

4. Consideration should be given to the installation of a public address system in buildings with floor area exceeding 30,000 square feet.

5-13 LIGHTNING PROTECTION

A. See 5-14 O, Fort Detrick Design Practices.

5-14 FORT DETRICK DESIGN PRACTICES

A. Scope

1. This subsection contains criteria and design information not related to biological safety considerations and is not intended to be comprehensive.

B. General

1. The post system voltages are as follows:

a. Transmission: 34.5 kilovolts, 3-phase, 3-wire 60-cycle, delta, with static wire.

b. Distribution: 4.16 kilovolts, 3-phase, 4-wire wye grounded.

c. Utilization

(1) Secondary voltages for new construction shall be 480 volts, 3-phase, 3-wire delta; 120/208 volts, 3-phase, 4-wire wye.

(2) In design of modifications to existing buildings installed voltage characteristics shall govern selection.

2. In general, the primary switch gear transformer and main secondary switch gear shall be of the outdoor weatherproof type. Each building shall have one load center for power and one for lighting. Power voltage transformation shall be 4.16 kilovolts delta to 480 volts delta 3-phase, 3-wire; lighting voltage transformation shall be 4,160 volts delta to 120/208 volts wye, 3-phase, 4-wire.

3. The system for each building shall be similar to a modified single radial.

C. Standardization of Service Voltage for Inductive Loads

1. Motors up to and including ½ hp. shall be rated at 115 volts, single phase, 60 cycles.

2. In design of modifications to existing buildings, installed voltage characteristics shall govern selection of motor voltages.

3. Motors 3/4 hp. and above shall be operated at 440 volts, 3 phase. However, 50 hp. and above shall be of the reduced voltage start. In cases where standard commercial items up to 2 hp. are not readily available with these voltage characteristics an exception may be considered.

4. Where 4160-volt motors are required, the 4.16 kilovolt motor starters shall be high-interrupting capacity control with current limiting fuses. Starters shall include surge pack.

D. Standardization of Service Voltages for Non-Inductive Loads

1. For ovens, incubators, and sterilizers consuming more than 1600 watts, 208 volts, 220 volts or 440 volts single phase shall be used. Above 4500 watts, 440 volts 3-phase, 3-wire shall be used.

2. In design of modifications to existing buildings installed voltage characteristics shall govern selection.

E. Lighting and Power Distribution Panels

1. The preferred method for controlling a number of motors shall be a free standing motor control center.

2. Allowance shall be made for anticipated load growth plus an amount for unforseen future requirements based on system and building size analysis.

F. Lighting

1. General lighting systems will normally be designed for use with fluorescent light sources and shall be layed out to suit lighting fixtures and lighting equipment using the 48-inch, T-12, 40-watt, rapid start type of lamp unless the particular job or special requirements dictate otherwise.

2. Acceptable Minimum Levels of Illumination (Special Areas)

Laboratories	75 Foot Candles
Walk-in refrigerators and incubators . . .	30 Foot Candles

Non-contaminated animal holding rooms . . 50 foot-candles

Contaminated animal holding rooms . . . . 75 foot-candles

Air locks . . . . . 20 foot-candles

G. Grounding

1. Grounding shall be in strict accordance with applicable sections of the National Electric Code.

2. A grounding conductor shall be run to all load centers, switchgear, distribution panels, major junction and pull boxes, lighting panels, and all equipment served by primary voltage.

H. Ultraviolet Requirements

1. See also 5-03.

2. Approved U.V. Components

a. Cold cathode lamps and fixtures shall be Westinghouse "Steri-lamps" 78ZL-30 with either the Westinghouse type SB-30 fixture for nonwatertight applications or the watertight fixture shown on Fort Detrick Drawing F-93-1-7651. Low ozone output lamps are required.

b. Hot cathode lamps and fixtures shall be the G15T8 "Steri-lamps" used in the watertight hot cathode fixture shown on Fort Detrick Drawing F-93-1-7551.

c. "Alzak" aluminum reflectors for fixtures (a) and (b) shown on Fort Detrick Drawings F-93-1-7651 and F-93-1-7551 respectively shall be used.

d. Protective louvers shall be installed on all door barrier fixtures.

I. Laboratory Equipment

1. See also 5-04.

2. Equipment and areas in which flammable materials are to be used or stored shall be provided with explosion-proof fixtures and devices, and installed in accordance with National Electric Code.

3. Laboratory tables shall be provided with 115-v service to built-in convenience outlets, and these shall be supplied with approved grounded receptacles. Specific requirements of this type of equipment shall be obtained from manufacturers' catalogs.

J. Miscellaneous Electrical Specialties

1. See also 5-05.

2. Heating and Ventilation

a. Thermostats shall be line-voltage load-rated type, wherever possible, to preclude the necessity of auxiliary contactors for operating the controlled loads.

b. Solenoid valves for small refrigeration units shall be operated on the service voltage supplied to the compressor unit and thermostats.

c. Oil and gas flame monitoring controls shall be 110 V, 60 cycle, grounded type only. (Circular 420-9 D.A. dated April 5, 1965.)

3. Electrical

a. Warning signs for high voltage hazards will be provided by the Government and installed by the contractor, except that contractor shall paint or otherwise provide marking of "4160 V" where applicable on exposed conduit in the manner directed by approved standard.

b. All circuit breakers shall have current capacity marked on handles, or on panel face beneath handles.

4. Electric Motors: Integral horsepower motors shall be factory equipped with prelubricated and sealed bearings similar and approved equal to such used in the Westinghouse Life-Line motor. Exception: Specialized applications which call for extremely high speeds, large shaft diameter, heavy rotor or armature loads, or other duties beyond manufacturer's recommendations.

a. All three phase motor starters shall have an overload in each leg.

K. Explosion-Proof Areas, Hazardous Location

1. See also 5-06.

2. Scope: The requirements of the National Electrical Code (Art.500) shall be strictly observed within the scope of these requirements; the areas of concern shall be considered as Class 1, Group D.

3. Wiring Methods: Shall be similar to Crouse-Hinds types EZD, EYS, EZS, ECD, GUAT, FLF, CFS, CPH, CPS, or approved equal.

4. Exposed Parts: The exposed non-current-carrying metal parts of equipment such as frames or metal exteriors of motors, fixed or portable lamps or appliances, lighting fixtures, cabinets, cases, and conduit shall be grounded as specified in Art. 250 of the N. E. Code.

5. Bonding: Shall be accomplished by use of bonding jumpers with proper fittings.

L. Fire Detection and Alarm Systems

1. See also 5-08.

2. Signal Transmitters

a. Automatic fire alarm system shall be a closed circuit type. The system shall be operated from 115 volt, single phase, 60 cycle current, through a rectifier with trickle-charged floating storage batteries to operated the system under trouble conditions for a period of 60 hours.

b. Alarm transmitters shall be of a type capable of transmitting a coded signal over a McCulloh circuit. Signal shunting contacts shall be provided to eliminate signal clashes between transmitters installed within the same building. All transmitters shall be grouped in one location.

c. Manual stations shall be installed adjacent to emergency exits, and at other appropriate locations.

d. Signal circuit shall be extended to an appropriate location on the exterior of the building, in order that circuits may be connected to the post fire alarm system without additional interior wiring.

3. Specifications for Installation

a. Alarm systems shall comply, in all respects not specifically excepted, with applicable provisions of the standards of the National Board of Fire Underwriters. Material shall be of a type approved by Underwriters Laboratories, Inc., or other nationally recognized commercial or U. S. Government testing laboratories.

b. The contractor shall ascertain that the fire detection and alarm system is installed in accordance with the manufacturer's recommended practice, and to the satisfaction of the Government.

c. The source of supply for a building fire alarm system, or any part of the system, shall be directly from the lighting load center transformer secondary through a suitable switch and circuit protection.

d. Where a fixed CO_2 extinguisher system is to be installed, a transmitter shall be furnished and connected to the fire reporting building system.

M. Closed-Circuit Television System

1. See also 5-10.

2. Design Requirements

a. Outlet boxes shall be of the cast type with threaded hub,

mounted in accordance with 5-02 B. Boxes shall be furnished with blank cover and neoprene gasket, boxes and covers shall be of the feraloy type.

b. Drawing approval procedure is the same as for "Telephone", as described in 5-14 N below.

c. A conduit shall be run underground from the terminal cabinet to the nearest service pole outside the building, terminate six (6) feet up the pole, and be capped.

N. Telephone Systems

1. See also 5-11.

2. Design Requirements

a. The contractor shall provide only a telephone conduit system in accordance with the Corps of Engineers' Engineering Manual, Part VI, Chapter 2, Section 2-16, where applicable; except as modified by the Signal Corp letter #6, File CSO-Ch. Engr. dated 7 March 1949, and by any 2nd Army Signal Corps special rulings for this activity.

b. There shall be at least one (1) outlet available in each valid office, laboratory, principle corridor, or utility space, and also in potentially valid working areas to be left for future development

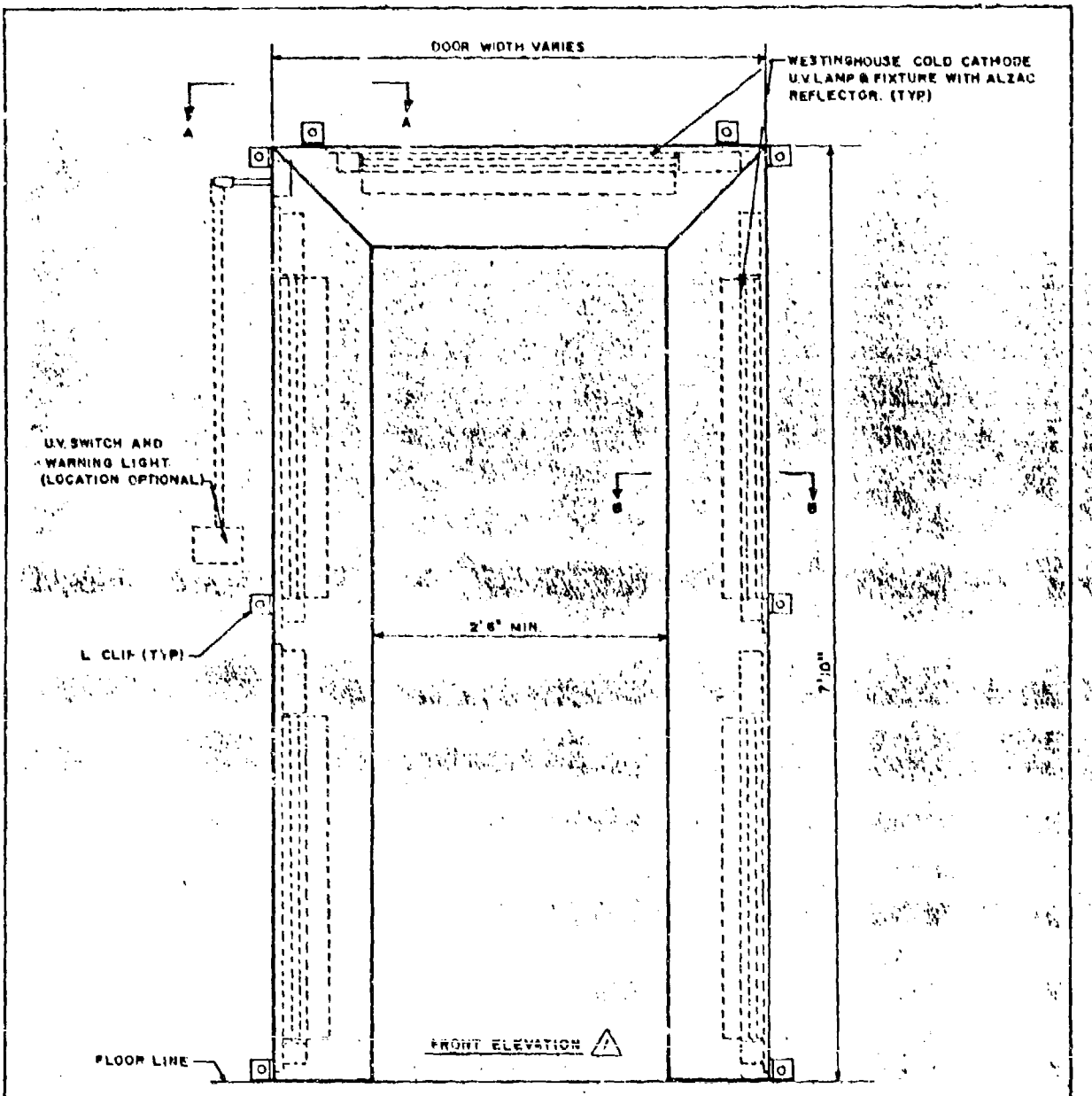
c. Preliminary drawings showing tentative outlet locations shall be submitted to the Contracting Officer for the approval and/or comments of the post Signal Officer.

d. The telephone conduit system outlet boxes containing covers with a ½" hole shall be furnished as directed by the Government.

e. Telephone conduit shall have fishwire provided.

O. Lightning Protection

1. Lightning protection shall be provided in accordance with requirements of the Safety Regulations for Lightning Protection, AMCR 385-224 and Corps of Engineers, General Safety Requirements E.M.385-1-1, or of any later revisions thereof.



NOTE

2 SEE UV DOOR BARRIER DWG S,F-93-1-7651 3 SHEETS FOR PROTECTIVE LOUVERS & OTHER DETAILS

REV	DATE	DESCRIPTION
2	OCT 89	ADDED NOTES
1	AUG 87	GENERAL REVISION

TYPICAL U.V. DOOR BARRIER

DATE-1FEB 86

PLATE NO. 5.1

4/70

SECTION 6 - INSTRUMENTATION AND CONTROLS

TABLE OF CONTENTS

LIST OF PLATES

SECTION 6

INSTRUMENTATION AND CONTROLS

6-00 INTRODUCTION

A. Scope

This section is addressed primarily to those architect-engineering personnel concerned specifically with the design of instrumentation and controls for microbiological facilities at Fort Detrick. It applies to new facilities, and to modifications and additions to existing facilities.

We repeat here again, as in every section, that the purpose of this manual is to present special design criteria based primarily on biological safety considerations. It is not intended to duplicate the fund of standards and criteria normally possessed by the architect-engineer. However, a sub-section of Fort Detrick Design Practices not related to safety considerations is given at the end of this section. In addition, Appendix A lists a number of Fort Detrick Purchase Descriptions and Specifications.

As described in Volume I, Fort Detrick contains a variety of facilities, such as laboratories, pilot plants, test chambers, filling lines, storage areas and others. This manual presents the criteria that all of these facilities have in common. To avoid vagueness, many of the criteria are stated in terms of laboratory buildings, but this should not be taken to mean that they are not generally applicable.

With some exceptions, the requirements peculiar to each type of facility are not covered in this manual.

B. Conversions and Modifications

The application of the criteria presented here to the design of new facilities generally will be straightforward. However, many projects involve the conversion or modification of existing facilities. Since these facilities were built there have been changes in the criteria, based on technical innovations or operating experience. As a result, it is important for the designer of such modifications to exercise judgment and flexibility in applying the new criteria. Some of the potential problems will be resolved by the specific Contract Scope of Work for the individual project or by other guidance provided by the Government.

C. Organization of Section 6

The remainder of this section is divided into the following main subsections:

1. General
2. Services

3. Building ventilation
4. Safety cabinets
5. Special rooms and equipment
6. Fire detection and alarm system
7. Process
8. Fort Detrick design practices

6-01 GENERAL

A. Safety Measures: In each instrument installation consideration shall be given to the potential application of each of the following measures for promoting biological safety and instrument reliability:

1. Duplication of Instruments: Duplicate instruments will be provided where failure will constitute a safety hazard or cause failure of an experimental process.

2. Fail-Safe: In case of power failure, loss of instrument air pressures, etc., the equipment will convert to the safe position.

3. Transducers: Instrument sensing lines connected to contaminated equipment or spaces shall not be connected directly to local or remote control panels without interposing a biologically safe transducer.

4. Remote Control or Shut-Off: For example, see 5-08 D.4, ELECTRICAL.

5. Remote Alarms: See 5-09 B, ELECTRICAL.

6. Annunciators: For indicating malfunctions or localizing source of trouble. For example, see 5-09 A and 5-09 B, ELECTRICAL.

B. Instrument Types: The instrumentation used for control systems throughout the facility shall be in general of the pneumatic type; however, electronic, electrical, or hydraulic systems may be considered for a specific application if a superior system will result from their use.

C. Calibration: Instruments used to obtain experimental data shall be calibrated by comparing with standards which are traceable and related to authoritative source standards such as those maintained by the National Bureau of Standards. A certification document of calibration shall be supplied with each instrument. Compliance with specification Mil-C-45662 shall be required.

D. Materials

1. Materials of Construction

Instrumentation used in the contaminated portion of a building may fall into one of two categories. The first situation is one in which the sensing or operational device is located in a contaminated area but the

/66

control instrument or recorder is in a less-contaminated area. The second situation is where both the sensing or operation device and the control instrument or recorder are in the same contaminated area.

Instruments or controls in the contaminated area shall be fabricated as far as practical of corrosion-resistant material capable of withstanding a variety of decontaminating solutions (see Appendix B). Instruments in contact with agents shall be constructed of material non-toxic to agent material.

2. Tubing: Pneumatic interconnections shall be made with copper tubing as called for in the piping specifications (see Appendix C). The use of non-flammable plastic tubing for instrument connections shall not be permitted but plastic coated copper tubing may be used in areas where decontaminants may attack copper. All tubing passing through walls or floors between a contaminated and non-contaminated area or between areas of different levels of contamination shall make this penetration via bulkhead fittings mounted and gasketed to steel plates set in the floor or wall. See Plate No. 1.17.

3. Panelboards: Panelboards in contaminated areas shall be of the free standing fully enclosed type furnished with fully gasketed doors hung with full-length piano hinges. All instruments shall be provided with gasketed transparent covers. In addition, a gasket shall be provided between the instrument bezel and the face of the panel. The panel shall be constructed of sheet steel with all joints welded and ground smooth. Dry air at 0°F dewpoint shall be used to purge the interior of cabinets and instruments installed in corrosive atmospheres.

All metallic surfaces shall be painted to protect against corrosion from decontaminating solutions. In pilot plant and other areas where higher levels of contamination may exist, the use of stainless steel should be considered.

4. Wiring: All instrument and control wiring shall be in rigid conduit or mineral-filled cable. All conduit passing through a wall or floor between a non-contaminated and a contaminated area or between areas of different levels of contamination shall be sealed internally as specified in 5-02 B.3, ELECTRICAL. Sealing around conduits shall also be as specified in 5-02 B.4. Entrance of instrument wiring into Class III cabinets shall be with mineral-filled cable and compression fittings to provide gastightness.

E. Installation: All instruments and controls shall be installed in such a fashion as to avoid crevices, cracks, and pockets. Conduit runs and instrument tubing shall be mounted off the wall as shown in Plate No. 3.2 to promote ease of painting and cleaning.

F. Instrument Air Supply (IA): See Section 3-02 M, PIPING, for details on the instrument air system.

6-02 SERVICES

A. Water Break Tank

1. Piping Arrangement: See Plate No. 3.5 for details on the water break tank used for the contaminated water service. The break tank make-up valve shall be a self-operated mechanical linkage type with stainless steel ball float. The valve shall have an inner pilot valve operated by the float to facilitate tight trouble-free shut-off when desired upper level is attained. The break tank shall be an atmospheric tank with water supplied at the top to prevent backsiphoning.

2. Controls: Water supply pump operation shall be controlled by a cage type float switch externally mounted on the surge tank. Electrode type level controls are not acceptable. The float switch shall start the pump on surge tank low level and shut down the pump on high level. The contaminated water (CCW) system pressure shall be maintained at 50 psig during use by means of bleeding compressed air (CA) to the tank through a pressure regulating valve. This will insure a constant water supply pressure for the building. A back pressure regulator shall relieve the excess air pressure in the surge tank during filling operations. An air pressure relief valve (vented to atmosphere) shall be installed to prevent excessive pressure in the tank. The tank shall be equipped with a sight glass and a water pressure gage accurate to ½ psi.

B. Back-Flow Preventer: A spring loaded ball type check valve may be used as a back-flow preventer in the CCW water line branches to the Class III cabinets. The use of these valves will serve to isolate the Class III cabinets from the laboratory bench top service water taps. A back-flow preventer used on the building supply shall be specified in accordance with "Cross-Connection Manual of Recommended Practices" by the Los Angeles Dept. of Health. (See Plate No. 3.3)

C. Waste Collection System

1. Batch Treatment: See Section 3-04 I, PIPING for a description of the system and the operational requirements for batch waste treatment and Plate No. 3.7 for a diagram of the system. Operation is manual with the necessary alarms and interlocks provided.

2. Continuous Treatment: See Section 3-04 I, PIPING for a description of the system and the operational requirements for continuous waste treatment and Plate No. 3.8 for a diagram of the system. Operation is automatic.

3. Controls: The waste collection tanks shall be provided with level, temperature, and time cycle controls for operation of the system. If requested by the Government, the control panel, with suitable manual by-pass controls, shall be located outside the waste collection treatment room.

If this is done, suitable remote-operated valves shall be provided for the batch system in place of the manual valves shown in Plate No. 3.7.

a. Level: The batch waste collection tanks shall be equipped with a level recorder to indicate the level of the tank contents at all times. The continuous system shall have a level recording controller which will shut off the steam supply and the tank discharge valve on low level; it will close the tank fill line on high level and simultaneously open the fill line for the spare tank. Both systems shall have a visible and audible alarm activated on high level.

b. Temperature: The batch waste collection tanks shall be equipped with a temperature recorder to show the temperature of the liquid in the tanks. The continuous system shall have a temperature recording controller which will modulate the 40 psig steam supply to maintain the required liquid operating temperature. The tank effluent shut-off valve will close automatically and sound an alarm if the required temperature is not maintained. Both systems shall be equipped with an indicating thermometer.

c. Pressure: Waste collection treatment vessels shall be provided with local as well as panel mounted pressure indicators. In no case shall pipes or tubing connected to the waste collection tanks be brought out of the tank area (see 6-01 A.3). Therefore, the control panel gage shall receive its signal from a transmitter located on the tank.

d. Timer: A timer shall be used for the batch operation to control the duration of the sterilization period. The timer should be connected to the temperature recorder so in the event the waste liquid temperature falls below the minimum operating temperature, the timer will reset and not commence timing until the liquid temperature rises again and exceeds the minimum operating temperature. On completion of the sterilization cycle a visual alarm shall light on the control panel.

e. Pressure Release: See 3-04 I.5, PIPING for details.

6-03 BUILDING VENTILATION

Ventilation controls and instrumentation are covered in Section 2-11, HV&AC.

6-04 SAFETY CABINETS

A. Pressure Gage: Magnehelic type gages for indicating negative pressure shall be provided for each isolated section of a cabinet system.

B. Pressure Switch: Each isolated cabinet section shall be provided with an alarm device which indicates with a buzzer and light when the cabinet internal pressure reaches -½" w.g. with respect to that of the room. The buzzer shall sound only when the condition exists; however, the light shall remain lighted until manually extinguished.

C. Interlocks: On individual biological safety cabinet systems using special internal environment, the individual supply shall be interlocked so that it will be non-functional unless the cabinet exhaust is operating properly. The interlocking pressure switch shall be separate from the alarm pressure switch called for in B above. See Plate No. 6.1 for a typical hook-up for special environmental atmospheres for Class III cabinets. See Section 2-06, HV&AC for details on the cabinet exhaust system.

D. Safety Cabinet Elevator: An elevator installed within a Class III safety cabinet shall be equipped with a manually operated, momentary contact push-button switch. Signal lights shall be provided to indicate the upper and lower limits of travel as well as the location of the car at all stops. Switches used for determining the car position shall be magnetic and mounted on the external portion of the elevator driveshaft. Position controls shall be accurate to $\pm$ ½" of the actual location.

E. Ventilation: See 2-11 F, HV&AC.

6-05 SPECIAL ROOMS AND EQUIPMENT

A. Animal Room: Each animal room shall have its own temperature and humidity control system which is to be manually set and shall be unaffected by resetting action of master controller of the main building system.

B. Flammable Material Storage: The flammable storage ventilation system damper and fan shall be interlocked with the CO_2 fire protection system so that the damper closes and the fan ceases operation when the CO_2 system is activated. See also 1-03 J, ARCHITECTURAL.

C. Refrigerators

1. Controller: Walk-in refrigerators shall have a temperature recording controller, externally mounted. The instrument shall have a 12-inch circular chart recorder for twenty-four (24) hour operation. The unit cooler fans shall be manually operated.

2. Alarm: The controller shall be provided with contacts connected to an alarm circuit to indicate excessive refrigerator temperatures outside the control range (see 5-09 B, ELECTRICAL).

3. Modification to Controls: All free standing refrigerators shall have the interior light switch and thermostat removed and the controls mounted outside of the refrigerator.

D. Incubators

1. Controller: Walk-in incubators shall have a wet and dry bulb temperature recording controller, externally mounted. The instrument shall have a 12-inch circular chart recorder for twenty-four (24) hour operation.

2. Alarm: The controller shall be provided with contacts connected to an alarm circuit to indicate unsuitable operating conditions outside the control range (see 5-09 B, ELECTRICAL).

E. Air Incinerator

1. Application: See 2-06 D.7, HV&AC.

2. Electric Incinerator

a. An electric type incinerator shall be used to incinerate small quantities of air (less than 100 cfm per unit) from Class III biological cabinet systems.

b. Information on equipment design will be furnished by the Government.

3. Combustion Incinerator

A combustion type incinerator shall be gas or oil fired and is used to incinerate large quantities of air from Class III biological cabinet systems, aerosol chambers, waste collection treatment units, discharge air from process equipment and any other unit which may discharge contaminated air. A temperature recording controller shall be installed to insure that a minimum of 550°F is maintained in the air leaving the combustion chamber to insure incineration of the bacterial agents in the air stream.

An alarm circuit shall be incorporated to indicate any malfunction in the fuel supply or low temperature operation.

F. Steam Sterilizer

1. Temperature Recorder: All steam sterilizers shall be installed with a temperature recorder to indicate the temperature and duration of the sterilization cycle.

2. Automatic Cycle Timer: Sterilizers may be equipped with automatic controls which control the sterilization cycle. Automatic controls are normally not necessary but may be specified by the Government for specific applications.

3. Door Interlocks: Automatic door interlocks that prevent simultaneous opening of both doors of double door sterilizers are not required; however, the sterilizers shall have interconnected door position indicator lights.

G. Fume Hood

1. Interlocks: The fume hood exhaust fan shall be shut off on stopping of the building exhaust fan.

2. Differential Pressure Control: A differential pressure indicator of the magnehelic type shall be installed across the fume hood bacterial filter to indicate the filter pressure drop.

H. Glassware Washer and Cage Washer

1. Temperature Control: The glassware washers and cage washers shall be provided with temperature recording controllers that will maintain the wash water in the wash tank at 180 F. The instrument shall be a 6" circular chart recorder for 7-day operation.

2. Interlock: There shall be no interlocks on the glassware washer and cage washer hood fans. These fans shall operate continuously.

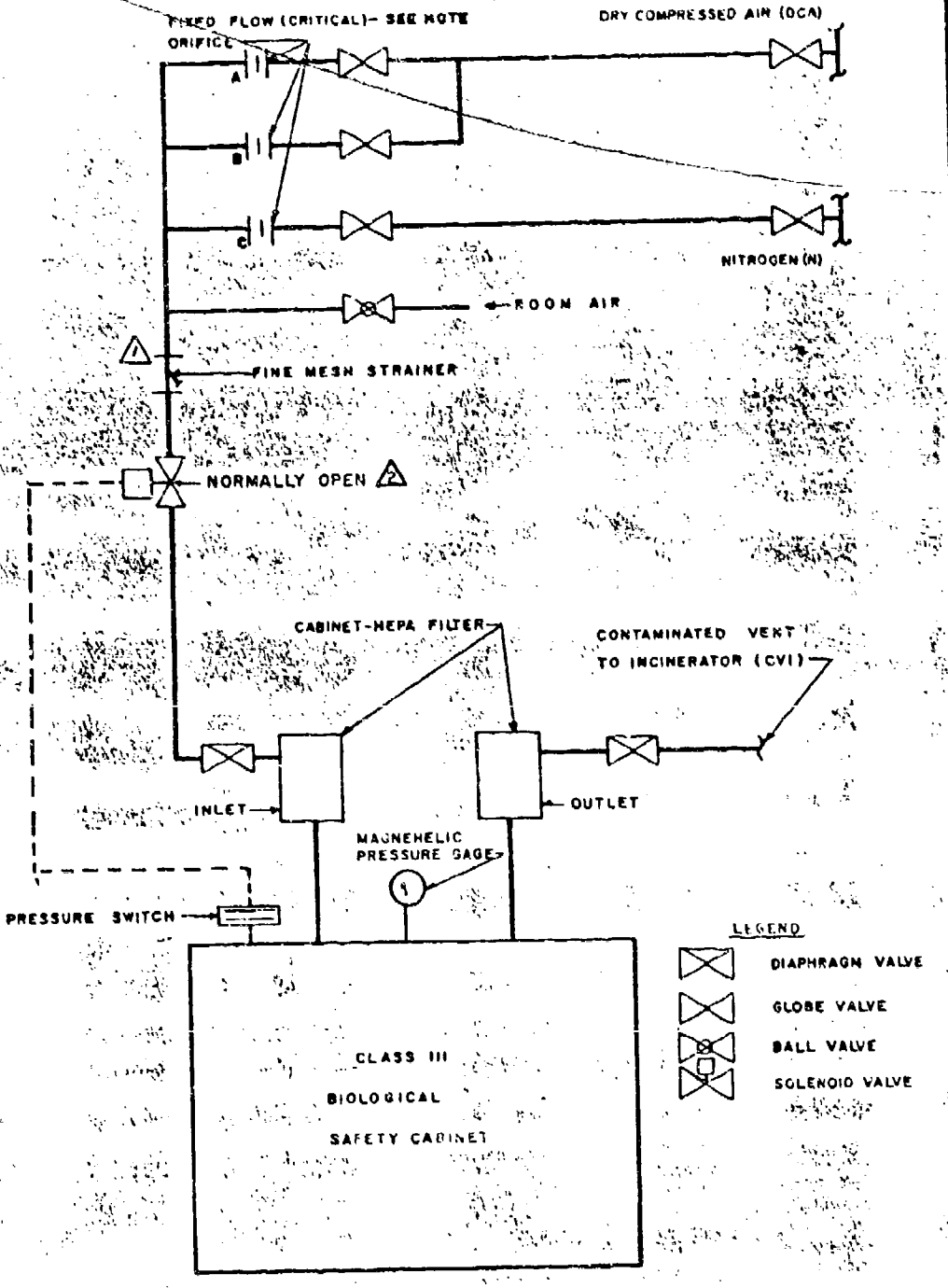
6-06 FIRE DETECTION AND ALARM SYSTEM

For details on the building fire detection and alarm system requirements see Section 5-08, ELECTRICAL.

6-07 PROCESS

A. Criteria: No special criteria are listed here for process instrumentation and control. Specific requirements shall be furnished by the Government. Process development control systems will require system analysis. A knowledge of the range of variables involved, the functional relationship and the acceptable control precision will be required before starting design of the instrumentation and control systems. These systems will require coordination between the architect-engineer and the scientific investigators to establish criteria and limiting parameters before the design is initiated.

B. Computer: Instrumentation shall be designed for data output necessary for direct process control. When requested by the Government, consideration shall be given to the selection of instrumentation equipment and systems with data output signals that can be recorded on punch tape or data cards compatible with the Fort Detrick digital computer.



NOTE.
DCA-THROUGH ORIFICE "A" ONLY
N- THROUGH ORIFICE "C" ONLY
DCA & N - MIXTURE THROUGH ORIFICES "B" & "C"
ORIFICE SIZES DETERMINED BY CABINET VOLUME SERVED
HEPA: HIGH EFFICIENCY PARTICULATE FILTER

REV.	DATE	DESCRIPTION
2	OCT 69	ADDED NOTE
1	AUG 67	GENERAL REVISION

CONTROLLED ATMOSPHERE PIPING FOR CLASS III CABINETS

DATE-1 FEB.66

PLATE NO. 6.1

GLOSSARY

Absolute Filter - see HEPA.

Aerosol - a suspension of very fine particles of solid or liquid in air or gas.

Agent - an infectious microorganism or toxin that is being handled in the course of research, process development, or testing.

Air Incinerator - see "combustion air incinerator" and "electric air incinerator."

Air Lock - an unventilated section of corridor isolated by doors, used to separate areas with different levels of contamination and at different air pressures, which permits passage of personnel and/or equipment without air flow. See also "U.V. air lock."

Air-tight or Airtight - see "gastight."

Aircraft Grade Compound - a sealing compound used for sealing biological safety cabinets and for other caulking uses where a gastight seal is required.

Animal Cage - container, generally metal but may be of plastic, either autoclavable or disposable, designed for permanent housing of (usually individual) animals; may be individually ventilated or open to surrounding atmosphere. Used in both non-contaminated and contaminated areas.

Animal Cage Rack - stack of steel shelves, generally movable, used to hold animal cages; sometimes equipped for U.V. irradiation and sometimes provided with exhaust manifold to accommodate ventilated cages.

Animal Holding Room - room with suitable isolation criteria used to house animals in cages before and after experimental use; may be in non-contaminated or in contaminated areas. Used interchangeably with "animal room."

Area - generally used in this manual to designate a portion of a building at a given level of contamination, as set off from adjoining portions of different contamination levels. Used somewhat interchangeably with "space."

Array - see "cabinet array."

Attic - an important utility service area for the laboratories; contains much service equipment, including the ventilation equipment.

Autoclave - a chamber used for heat sterilization of materials and equipment by direct exposure to steam under pressure. An autoclave that has been modified to permit optional use of a gaseous decontaminant instead of steam is generally referred to as a "gas sterilizer" in this manual. See also "gas sterilizer."

Back Flow Preventer - a manufactured piping device of the type that has two spring-loaded vertical check valves and one spring-loaded, diaphragm-activated differential pressure relief valve. It is installed in a water supply line to prevent reversal of water flow in case the supply pressure falls below the downstream pressure. See also "break tank" and "vacuum breaker."

Bacterial Filter - used to remove microorganisms and other undesirable particulates from air or other gases. Includes "high-efficiency filters" and HEPA as well as less efficient types.

Biological Filter - see "bacterial filter."

Biological Safety Cabinet, Class I - see "Class I biological safety cabinet."

Biological Safety Cabinet, Class III - see "Class III biological safety cabinet."

Biological Spill Alarm - a system provided in large infectious disease buildings to warn building occupants that release of hazardous material has occurred. Alarm switches are conveniently located throughout the building and give a coded audible signal and actuate a warning light.

Biologically Separated - term applied to areas that are isolated from each other by change rooms and shower.

Blowcase - see "waste collection treatment unit."

Break Tank - a tank that provides an air space in a water supply line in such a manner as to prevent reversal of water flow in case the supply pressure falls below the downstream pressure. It is considered more positive than the back flow preventer or vacuum breaker.

Cabinet, Class I - see "Class I biological safety cabinet."

Cabinet, Class III - see "Class III biological safety cabinet."

Cabinet Array - a number of Class III biological safety cabinets joined together. An array may be divided into two or more cabinet systems by gastight doors or fixed partitions.

Cabinet System - a number of Class III biological safety cabinets joined to provide a single space with a single inlet and exhaust for ventilation.

Cage - see "animal cage."

Cage Rack - see "animal cage rack."

Carboxiclave - name previously given to an autoclave modified for use with carbon dioxide - ethylene oxide gas mixture; see "gas sterilizer."

Caulking - see "aircraft grade compound" and "construction grade compound."

Change Room(s) - grouping of dressing rooms, locker rooms, lavatories, air lock, and showers to provide personnel access to and egress from contaminated areas without allowing escape of contamination; see also "clean change room" and "contaminated change room."

Class I Biological Safety Cabinet - a prefabricated ventilated enclosure that provides a physical barrier between a worker and a hazardous operation. It may be used with an open front (or open glove ports) and a high rate of ventilation away from the operator, like a fume hood, or with a closed front and attached rubber gloves. In the latter use, protection depends upon a negative pressure maintained within the cabinet. The ventilation air exhausts through a high-efficiency filter.

Class II Biological Safety Cabinet - this designation is no longer used.

Class III Area - see "ventilated suit area."

Class III Biological Safety Cabinet - a prefabricated, gastight, ventilated enclosure maintained at negative pressure, in which work is done using attached rubber gloves, with HEPA filters on the inlet and exhaust, and with provision for exhaust air incineration.

Clean - has been commonly used in the past to mean "free of harmful micro-organisms," but has been replaced by "non-contaminated" (except in the term "clean change room") to avoid possible confusion with the special meaning (of being dust-free) given to "clean room" or "clean area" in the aerospace industry.

When used in this manual "clean" has its ordinary meaning of "unsoiled," without reference to microorganisms.

Clean Change Room - dressing room for removal of street clothes and donning laboratory clothing before entering contaminated change room through an air lock. (This term is an exception to the use of non-contaminated instead of clean.)

Clean Room - see "clean".

Clean-to-Contaminated Axis - a hypothetical line along which there is unidirectional flow of non-contaminated materials (including ventilation air) toward, and of contaminated materials away from, the contaminated work area.

Combustion Air Incinerator - a fuel-fired furnace for the sterilization of contaminated air (or other gases), in which all gases will have reached a minimum temperature of 550°F (measured at the stack base) before being discharged. Used for larger capacities than electric air incinerators.

Construction Grade Compound - a sealing compound used for all exterior and interior caulking, except where aircraft grade compound is required (see "aircraft grade compound").

Contaminated - synonymous with "potentially contaminated", i.e. any material, equipment, person, or animal in a contaminated area is considered to be contaminated with infectious microorganisms.

Contaminated Area - a building area with definite boundaries where hazardous biological work is being carried out, separated from non-contaminated and other contaminated areas by suitable barriers.

Contaminated Change Room - dressing room for removal of laboratory-type clothing before entering clean change room, through a mandatory shower, to don street clothing.

Contaminated Service - a service or utility, such as water or vacuum, which serves a contaminated area and is therefore segregated from similar services to non-contaminated areas, even though the service itself is non-contaminated.

Contaminated Suite - a group of contaminated laboratory rooms that is isolated from non-contaminated areas and other contaminated areas by change rooms and U.V. air locks.

Decontamination - the word "decontamination" is a provincial term used at Fort Detrick to describe all sterilizing, disinfecting, sanitizing, and washing procedures.

Decontamination Shower - see "disinfectant shower".

Deep-Bed Filter - common form of high-efficiency filter for low pressure use in ventilation system.

Demand Factor - Per cent of total connected load (for utilities).

Diaphragm Valve - widely used in contaminated service because of zero leakage at the stem (also referred to as "Saunders valve").

Disinfectant Shower - unit at exit from ventilated suit area in which suit is externally decontaminated by mist or spray of disinfectant, such as peracetic acid, before being removed.

Dirty - as used in this manual, generally means "contaminated," but the latter term is preferable.

Dollinger Filter - see "pipe line filter."

Electric Air Incinerator - an electrically heated chamber for sterilizing contaminated air or other gases by heating it to a minimum temperature of 575 F for 3 seconds. Generally used for smaller capacities than combustion air incinerators.

Exfiltration - (ventilation term) ductless flow of air from a space to an adjoining space at lower pressure.

Filter - see "bacterial filter."

Freon-tight - see "gastight."

Fretoclave - name previously given to autoclave modified for use with Freon - ethylene oxide gas mixture; now called "gas sterilizer."

Gas Sterilizer - an autoclave that has been modified to permit optional use of a gaseous decontaminant instead of steam for sterilizing materials.

Gastight - free from leakage when subjected to the standard halogen leak test, as defined in subsection 4-18, EQUIPMENT.

Germfree - free of all microbial life detectable by examination.

Glove Box - see "Class III biological safety cabinet."

Gravity Exhaust - (ventilation term) discharge of air, resulting only from pressure differential, from a ventilated room to the outdoors through an exhaust duct.

HEPA (Absolute) Filter - having a minimum efficiency of 99.97% when tested with 0.3-micron DOP particles.

High-Efficiency Bacterial Filter - see "high-efficiency filter."

High-Efficiency Filter - having a nominal efficiency of 95% for removal of 1- to 5-micron particles from air.

Hood Area - see "ventilated suit area."

Incinerator - see "combustion air incinerator," "electric air incinerator," and "refuse incinerator."

Infectious Agent - see "agent."

Infectious Microorganisms - as used in this manual, the term is restricted to microorganisms infectious for man or domestic animals.

Infiltration - (ventilation term) ductless flow of air into a space from an adjoining space at higher pressure.

Laminar Airflow Safety Cabinet - a prefabricated ventilated enclosure provided with a vertical-flow recirculating air system and generally operated as an open-front cabinet. This cabinet provides a sterile work environment and is at least as effective as the Class I cabinet in preventing escape of airborne particulates from the cabinet.

Laminar Flow - straight-line, eddy-free flow, applied specifically to air flow as a means of controlling spread of aerosols in the ventilation of contaminated work areas. Employed in clean rooms, downflow rooms and crossflow rooms in the aerospace and pharmaceutical industries.

Mask - self-contained "gas mask" covering eyes, nose and mouth, in which inspirated air is purified by charcoal adsorption and "absolute" filter; see also "respirator."

Mask Air - piped supply of conditioned air for personnel ventilated suits and hoods (see ventilated suit). "Mask air" is a misnomer, because face masks and respirators use room air inspirated through filters or charcoal canisters.

Microorganisms - in this manual, when not qualified, refers to infectious microorganisms.

Non-Contaminated Area - an area with definite boundaries designed to be free of harmful microorganisms; same as "uncontaminated areas." See also "clean."

Non-Contaminated Change Room - see "clean change room."

Particulate Filter - see "bacterial filter."

Pass Box - a double-doored chamber arranged to permit transfer of material and equipment between two confined spaces of different contamination level such as a safety cabinet and the room, two safety cabinet systems, a room and a corridor, etc. May employ steam, gas, U.V. radiation, or liquid as the decontamination agent. See also "autoclave," "U.V. pass box."

Pasteurization - heat treatment of a liquid under conditions of time and temperature that will substantially reduce, but not completely eliminate, the population of microorganisms.

Pipe Line Filter - a high-efficiency filter, using a throw-away cartridge of fiber glass filter medium, designed for sterilization under pressure in an all-welded piping system; also referred to as a "Dollinger filter" (see also "Type I filter medium").

Plenum - when not otherwise specified, refers to filter chamber upstream of exhaust fan in the building ventilation system.

Post-Wide Alarm System - a system to detect abnormal operation of any critical or important mechanical device or system. Warning is given at a building annunciator panel and at a central annuciator panel that is manned 24 hours a day.

Pressure-Tight - free from leakage in soap test at +4 in. w.g. pressure.

Process Piping - piping (other than waste piping) intended to carry product or agent.

Product - material that contains agent.

Receiving Room, Contaminated - an area for holding contaminated equipment and materials until they can be sterilized and passed through double-door autoclaves or gas sterilizers that open into the non-contaminated receiving room.

Receiving Room, Non-Contaminated - a service room generally at the rear of the building that is maintained as a non-contaminated area. Supplies delivered to the building are placed in the receiving room before transfer through a UV air lock to the contaminated receiving room.

Refuse Incinerator - a fuel-fired furnace for the combustion of organic wastes, in which all gases will have reached a minimum temperature of 1,350 F before discharge.

Respirator - a conventional device covering the nose and mouth, which provides a filter for inspirated air.

Rodent-Proof - incorporating prescribed structural and architectural features in building design that prevent access or harboring of rodents and other vermin.

Safety Cabinet, Class I - see "Class I biological safety cabinet."

Safety Cabinet, Class III - see "Class III biological safety cabinet."

Safety Shower - provided in chemical and radiological laboratories for same function as in conventional, non-biological laboratories.

Sealant - see "aircraft grade compound" and "construction grade compound."

Service Piping - piping other than waste piping or process piping.

Shower - see "change room," "disinfectant shower," and "safety shower."

Simulant - non-infectious microorganisms used as substitute for infectious microorganisms in testing processes or effectiveness of safety measures.

Speaking Diaphragm - plastic sheet installed in wall, door, or window to permit voice communication through barrier between areas of different levels of contamination.

Steam Seal - section of process piping between two valves, kept filled with steam when not in use, to isolate an agent-containing vessel or line from another process vessel or process line, from waste drain lines, etc.

Sterilization - complete destruction or inactivation of microorganisms.

Sterilizer - see "autoclave."

Suit Area - see "ventilated suit area."

Suite - see "contaminated suite."

System - see "cabinet system."

Toxin - a metabolic product of microorganisms poisonous to man or animals.

Type I Filter Medium - spun glass wool mat of 1.28-micron fibers used in high-efficiency filter.

Type II Filter Medium - spun glass wool mat of 2.54-micron fibers generally used ahead of Type I medium in high-efficiency filter.

Ultra-High-Efficiency Filter - see HEPA.

U.V. Air Lock - an air lock located between areas of different levels of contamination and air pressure. It provides a dead air space for the transfer of personnel and/or equipment without air flow. The interior is irradiated with U.V. and painted with aluminum paint to give good U.V. reflectance (see also "air lock").

U.V. Clothing Discard Rack - a rack that holds a standard laundry bag and is protected at the top with a curtain of U.V. Clothing worn in the contaminated laboratory is discarded into this laundry bag in the contaminated change room.

U.V. Pass Box - a pass box in which U.V. radiation is used for surface decontamination of material or equipment (see "pass box").

Uncontaminated - same as "non-contaminated."

Vacuum Breaker - a device that is installed in a line or tank, where the breaker is not subjected to a downstream back-pressure, to prevent reversal of flow in case of accidental occurrence of an upstream suction.

Ventilated Cages - see "animal cages".

Ventilated Hood - hood covering entire head, pressurized with conditioned air by same hose system serving ventilated suits.

Ventilated Suit - pressurized outer garment, including head, hands and feet, supplied by hose with conditioned air, worn in areas of high risk from infectious aerosols such as some animal rooms.

Ventilated Suit Area - area of high hazard, in which workers are protected by ventilated suits, and which is separated from adjoining area of lower contamination risk by various barriers to spread of contamination, including change room provided with disinfectant shower.

Vermin Proof - see "rodent proof".

Viewing Panel - fixed window suitably sealed into an interior wall or door between two areas of different contamination level.

Viewing Window - see "viewing panel".

Waste Air Incinerator - see "combustion air incinerator" and "electric air incinerator".

Waste Collection Tank - see "waste collection treatment unit".

Waste Collection Treatment Unit - a waste collection and treatment unit, generally serving one building, consisting of a tank in which the contaminated liquid waste is collected, sterilized or pasteurized by steam, either continuously or batch-wise, and discharged to the main contaminated waste system. Commonly called "blowcase".

Waste Piping - unless specified as "sanitary", refers to piping handling contaminated waste.

APPENDIX A HAS BEEN ELIMINATED IN TOTO FROM THIS REVISED EDITION

21. Air Filter Medium	RMW-21	7 Jun 63
22. Freeze Dryer	LJD-22	19 Jun 63
23. Unitary Air Conditioner	EJS-23	21 Jun 63
24. Air Supported Structure	FBR-24	9 Oct 63
25. Walk-In Refrigerator	RWS-25	23 Oct 63
26. Air Handling Unit and Exhaust Fan	RWS-26	23 Oct 63
27. Lab. Equip. and Utilities for Mobile Lab Unit	HGC-27	Nov 63
28. Air Incinerator, Pur WO2799, Req. 4184	RWS-28	13 Dec 63
29. Exhaust Fan	JDN-29	16 Dec 63
30. Walk-In Refrigerator	RWS-30	17 Dec 63
31. Chamber	RMW-31	19 Mar 64
32. Oil-Free Compressed Air System	LMJ-32	3 Feb 64
33. Single-Phase Conv. Distribution Transformer	RJJ-33	26 Feb 64
34. Inflatable Structure, Transparent	FBR-34	11 Mar 64
35. Laboratory Type Doors	WEE-35	19 Mar 64
36. Pathogen Chamber	LMJ-36	8 Apr 64
37. Walk-In Freezer	RWS-37	13 Apr 64
38. Comb. Air Pressure Blower	EJS-38	17 Apr 64
39. Ultrasonic Cage Washer	AAW-39	17 Apr 64
40. Lab Sterilizer, 20 x 20 x 36	EAB-40	17 Apr 64
41. Carbon Dioxide Incubator	RWS-42	19 Apr 65
42. Single Phase Conventional Dist. Transformer	JSB-43	5 May 65

APPENDIX B - MICROBIAL DECONTAMINATION

TABLE OF CONTENTS

LIST OF PLATES

APPENDIX B

MICROBIAL DECONTAMINATION

B-00 INTRODUCTION

Every infectious disease laboratory uses a variety of physical and chemical methods for sterilizing, disinfecting, sanitizing, and decontaminating equipment, areas, materials, and personnel. These various physical and chemical procedures and treatments, unique to the infectious disease laboratory, have a decided influence on many phases of the design of these laboratories.

The word "decontamination" is a provincial term used at Fort Detrick to describe all sterilizing, disinfecting, sanitizing, and washing procedures. The word has been extended from its true meaning and usage in the Chemical Corps which means: to rid of poison gas. The word decontamination will be used in its broadest sense here to mean: to free of contamination. This freeing of contamination can be accomplished by washing with air or water or by any of a number of physical or chemical methods.

B-01 DECONTAMINANTS

The design of equipment, materials of construction, and arrangement of facilities may be affected by the decontaminants to be used in the facility. The various physical and chemical methods of decontamination applicable to the infectious disease laboratory may be classified under one of four main headings: (a) heat, (b) liquids, (c) vapors and gases, and (d) radiation.

A. Heat

Heat, either dry or moist, is the most effective method of inactivating microorganisms. The exposure times and temperatures required for sterility are known and can be readily controlled. The steam-pressure autoclave is the most widely used mechanism in the laboratory for sterilizing materials. There are two general types of autoclaves in use. The standard autoclave is operated at 15-20 psig (121-127°C) and operates best with a source of steam between 50-60 psig at the sterilizer. The sterilization cycle varies from ½ hour to 3 hours depending upon the size of the autoclave and the load. Basic time-temperature requirements for accomplishing sterilization in saturated steam are:

15 min at 250°F (121°C) - 15 psig steam
10 min at 259°F (126°C) - 20 psig steam
3 min at 273°F (134°C) - 30 psig steam

High-vacuum, high-temperature autoclaves will complete a sterilization cycle in from 8 to 17 minutes. High-vacuum autoclaves are evacuated of air to less than 20 mm of mercury and then steam is introduced to 33 psig (275°F). The vacuum may be produced by a vacuum pump or steam

ejector or by a combination of both. This high-vacuum, short-cycle, autoclave not only gives a 4 to 5 times speed-up in processing materials, but the shorter exposure period is less damaging to rubber goods, fabrics, and other materials. A 100 psig steam service is required to operate the steam ejector.

Electric air incinerators of 15 cfm and 100 cfm capacities and oil-fired incinerators of 2,200 cfm and 6,000 cfm capacities are described in Section 2, HV&AC. As a general guide, the following temperatures and retention times can be used to sterilize air contaminated with heavy concentrations of bacterial spores:

425°F - 24 seconds retention time
475°F - 10 seconds retention time
525°F - 5 seconds retention time
575°F - 3 seconds retention time

B. Liquids

Hundreds of liquid germicides are available under a variety of trade names. Most can be classified as halogens, acids, alkalies, heavy metal salts, quaternary ammonium compounds, phenolic compounds, cresolic compounds, aldehydi compounds, alcohols, and other organic preparations. None are equally useful or effective under all conditions. There are many misconceptions concerning the use of liquid disinfectants that are due largely to the fact that such liquids may perform dramatically in the test tube evaluation and yet fail miserably in a practical situation. Failures often occur because too little consideration is given to such factors as temperature, contact, pH, concentration, and the presence of organic material at the site of application. Small variations in these factors may make large differences in germicidal effectiveness.

In the decontamination of rooms or other large areas after accidental spills or during routine clean-up, the mechanical removal of microorganisms by washing is an important factor. For this reason, surface-active agents such as quaternary ammonium compounds are often used or incorporated with other germicides. Also, in the decontamination of large areas, a decontaminant must be used that is active in low concentrations. It is obvious that 5 per cent phenol would not be suitable, because at that per cent, 166 lbs. of phenol for each 100 gal. of water would be needed. This large amount of phenol would be difficult to prepare and would be expensive. On the other hand, hypochlorite solution or quaternary ammonium salts in a concentration of 0.05% are inexpensive, and the solutions are easily prepared. The quaternary ammonium compounds are often used in large area decontamination because these compounds are non-toxic, non-corrosive, and have no odor. Furthermore, they are highly surface active so that they are good detergents and cleaning compounds.

In some process development areas where large amounts of concentrated or dried materials are processed, a piped decontamination system

may be installed with outlets, hose, and spray nozzles mounted in various strategic locations. In many laboratories, a 3 gal. garden-type insecticidal sprayer is maintained in a condition ready for use in the event of an accident or for routine decontamination and clean-up. In the event of a spill, a pressurized spray should never be directed against the free material because an infectious aerosol will be formed. The area of the spill should be gently flooded with the liquid disinfectant, which is allowed to remain in contact with the spilled material for several minutes before being washed into the drain.

Liquid disinfectant spray systems are often installed in pass-through boxes or air locks attached to cabinet systems so that materials that cannot be autoclaved can be removed from the cabinet system. These spray systems may use any liquid disinfectant including 2 per cent peracetic acid. The most common use of a disinfectant spray system in a pass-through box is for the removal of viable agent in a glass or plastic bottle that is in turn hermetically sealed in a metal can.

Disinfectant spray systems also are used in shower rooms where ventilated suits are worn. The surfaces of the suits are decontaminated with a disinfectant such as peracetic acid as the individual leaves the suit room.

C. Vapors and Gases

A variety of vapors and gases are used in the biological laboratories for the sterilization of closed spaces. Ethylene oxide, formaldehyde, beta-propiolactone, and peracetic acid are in general use. Peracetic acid is included as a space disinfectant because it is sprayed as a fine mist and is used to decontaminate ventilated cabinets, germ-free isolators, and similar enclosures. Ethylene oxide is used to sterilize materials in gastight enclosures such as autoclaves because ethylene oxide is an extremely active penetrating gas and will escape rapidly through minute openings. Ethylene oxide is used in a concentration of about 400 mg per liter (0.4 oz. per cu. ft.) with an exposure time of about 4 hours. It has become standard practice at Fort Detrick to load autoclaves for ethylene oxide sterilization in the late afternoon and allow them to stand overnight, which gives an exposure time of about 16 hours.

Formaldehyde (37 per cent solution) is generally disseminated with steam in a concentration of 1 cc of formaldehyde solution per cu. ft. of space. The formaldehyde solution generally is mixed as five parts of formalin solution to three parts of methanol. This aids in preventing polymerization of the formaldehyde during use.

Beta-propiolactone (BPL) is disseminated with steam in a manner similar to the methods used with formaldehyde. The BPL must be well vaporized to prevent particles of BPL liquid from falling on surfaces because BPL in the liquid state is a good solvent for organics. The BPL is disseminated in a concentration of one gallon for each 16,000 cu. ft. of

space. In making this calculation, as with formaldehyde, any airflow through the space being treated must be taken into account and additional BPL added to obtain the proper concentration. After a holding period of two to three hours, doors and windows may be opened and forced ventilation started. At this time, entry into treated areas should be made only with protective clothing and respiratory protection. Proper airing will generally allow normal entry after another two to three hours.

Peracetic acid is a highly effective liquid disinfectant that can be sprayed as a fine mist or a vapor in a 2% solution to sterilize surfaces in small enclosures such as air locks or ventilated cabinets.

D. Ultraviolet Radiation

In certain specific applications, germicidal ultraviolet (U.V.) radiation is an effective means of decontaminating air and smooth surfaces. Cold cathode, low-ozone-producing U.V. lamps are used in air locks and door barriers to separate non contaminated from contaminated areas, or are used to isolate areas of differing levels of contamination within the building. Ultraviolet is also useful for reducing extraneous contamination in laboratory, incubator, and refrigerator rooms.

Ultraviolet radiation can be used to decontaminate air in recirculating systems for single rooms after the air has passed through roughing or low-efficiency filters to remove the dust. Air sterilizers utilizing ultraviolet have been developed for sterilizing small volumes of air containing high concentrations of bacterial spores. This air sterilizer operates at a flow rate of 1 cfm and utilizes four G10T6 U.V. lamps enclosed in aluminum tubes. Air entering at the end of one aluminum tube flows over the U.V. lamp in that tube and out the other end into and through each of the other three tubes in turn. The U.V. lamps produce a large amount of 2537A wavelength radiation in each of the 1-3/8 inches diameter tubes and have a life expectancy of 6,000 hours. The lamps are operated from an outside ballast supplying 420 milliamperes current to each lamp. The apparatus is approximately 4 inches x 4 inches x 38 inches long and weighs 20 lbs, including the ballast. At a flow of 1 cfm, the exposure time of air-borne particles in the sterilizer is 5.5 seconds (1.4 seconds per tube). Each U.V. lamp produces 11 watts of U.V. energy and causes a 20°F temperature rise in the air passing through the unit.

In infectious disease laboratories it is necessary to decontaminate papers used for recording data in the laboratory before they are passed to the non-contaminated area. Although sterilization can be effected by autoclaving or by treatment with ethylene oxide gas, time or facilities may make these methods impractical. A pass-through chamber utilizing high intensity U.V. radiation is used for decontaminating single sheets of paper. This U.V. sterilizer is 24½" long x 5" wide x 5" deep and is installed in a wall separating an infectious area from a non contaminated area. When a single sheet of paper is inserted into a slot on the front of the U.V. sterilizer, it is caught by two revolving rollers which

2/66

move the paper at a controlled rate past four, 15 watt U.V. lamps (G15T8 lamps, Westinghouse Elec. Corp). Each side of the sheet receives radiation from two lamps. The rollers are driven by a small 10 rpm electric motor that moves the paper one inch each 3.25 seconds. The total radiation received by the paper is about 7,500 microwatt-minutes per sq. cm or 4,500,000 ergs per sq. cm. This U.V. sterilizer provides a rapid method of decontaminating single sheets of paper as they are passed from a contaminated to a non-contaminated area.

Proper use of U.V. as a decontaminating agent requires an exact understanding of its limitations. This 2537A wavelength has little penetrating power and thus is most effective on smooth exposed surfaces or on microorganisms suspended in the air. Proper U.V. intensity, exposure time, and lamp maintenance are critical. The U.V. output must be measured with a meter since the emission of visible violet light does not show whether the lamp is operating at zero or 100 per cent of capacity of 2537A energy. The accumulation of dust, dirt, and grease on the surface of the U.V. lamp will reduce the output of 2537A radiant energy drastically. Therefore, lamps must be cleaned at appropriate intervals to maintain rated output.

B-02 CHARACTERISTICS OF THE MOST COMMONLY USED DECONTAMINANTS WHICH MAY AFFECT DESIGN

A. Heat

Every laboratory room or laboratory suite will be equipped with an autoclave. The autoclave may be a free-standing, single door type or a double door type installed through the wall of in a Class III cabinet system. All items removed from the cabinet system will be sterilized before removal. All glassware will be sterilized before it leaves the laboratory room or laboratory suite. Generally, autoclaves will be round, 16 in. diameter by 24 in. or 36 in., or will be of the square type 20 in. x 20 in. x 36 in. or 24 in. x 24 in. x 36 in. Autoclaves may be equipped for automatic operation or may be manually operated. If manually operated, the autoclave should be equipped with a temperature recorder. Those autoclaves installed in a Class III cabinet may be equipped with electrically operated doors.

A glassware sterilizing oven of a suitable size will be installed in each glassware washing room. These ovens are used to sterilize glassware by exposure of the glassware to 320°F (160°C) for four hours.

Air incinerators range from a 1 cfm size to 6,000 cfm. The 1 cfm, 16 cfm and 100 cfm air incinerators use electric heaters. The 2,500 cfm incinerator is oil-fired and the large 6,000 cfm incinerators are either oil-fired or utilize natural gas. Treatment of air by heat is expensive and is limited to those situations where the air is known to be heavily contaminated with infectious microorganisms. In general, heat treatment of air is limited to air that passes through fermentors or pro-

duction vessels, air discharged from aerosol test chambers and air from equipment and processes known to produce aerosols such as drying and grinding procedures. Because an incinerator does not "fail-safe", usually it must be preceded by a bacterial filter.

B. Liquids

Liquid decontaminants may be alkaline, acidic, strong oxidizing or reducing agents, or organic solvents. These may affect design or materials of construction. Some of the physical and chemical properties of the most commonly used liquid decontaminants are as follows:

1. Phenol: Phenol is generally used as a 5 per cent solution against vegetative type bacteria, some pathogenic fungi, and some viruses. It is not effective against bacterial spores. Phenol (or carbolic acid) is a white crystalline mass with a very characteristic odor. It is soluble in water to the extent of about 7 per cent and is highly soluble in most organic solvents. It is toxic when ingested and can be absorbed through the unbroken skin. Phenol reacts readily with many compounds to form resins, dyes, and other organic compounds. It is not corrosive to metals at room temperatures, but at elevated temperatures phenolic compounds will attack a variety of metals. In the laboratory, equipment such as pipettes and syringes are likely to be discarded into a pan of phenol solution and at the conclusion of the work, the pan of materials may be sterilized by autoclaving. If metal objects are also present in the phenol solution, some damage to the metal may take place.

2. Hypochlorite: Chlorine compounds were first used as chlorinated soda solutions in 1825 for the treatment of infected wounds and the purification of drinking water. Chlorine is an active germicide against all microorganisms. In the Biological Laboratories it generally is reserved for use against bacterial spores. As a rule sodium hypochlorite is used in a solution to give from 500 to 5,000 ppm of available chlorine. Common household bleach contains 5.25% (50,000 ppm) of available chlorine and can be diluted 1 to 10 to give an effective sporocidal solution. Chlorine is a strong oxidizing agent and attacks practically all metals. Organic chlorinated compounds and chlorine compounds maintained at a high pH are less corrosive to metals, but are also less effective sporocidal agents. Polyvinyl chloride sheet is resistant to attack by chlorine solutions and certain coatings such as epoxy resins are highly resistant. Surface active agents such as Nacconol or Duponol C usually are added to sodium hypochlorite solutions. These surface active agents make hypochlorite a more effective sporicide especially against desiccated microorganisms, but the corrosive action of the solution is increased. Bare metals, except stainless steel, should not be exposed in the laboratory. Suitable coatings should be applied to all surfaces in the laboratory that are likely to be damaged by exposure to hypochlorite solutions. Even stainless steel will be damaged by hypochlorite solutions if exposed for long periods of time.

3. Quaternary Ammonium Compounds: The cationic surface active agents are widely used as decontaminating solutions against vegetative type bacteria because they are non-toxic, non-corrosive, odorless, and inexpensive. They are used in a 0.1% to 1% concentration of active ingredient and are often used to wash and decontaminate rooms and large areas by spraying. The quaternary ammonioum compounds (QAC) are wetting agents, detergents, and emulsifying agents and are therefore excellent materials for washing and cleaning areas. Although the QAC's are not corrosive in themselves, the fact that they are surface active and lower interfacial tensions causes much more rapid corrosion to metals by water and compounds that may be present in the water. The QAC disinfectants will cause oil base paints to become tacky and they may cause changes in some plastics such as the polyvinyl chlorides by withdrawing the plasticizer from the material.

4. Cresol and Saponated Tricresylic Acids (Lysol): The cresylic acid disinfectants are usually saponated and used in a 2% solution. They are excellent decontaminating agents against vegetative bacteria and most viruses. Corrosive action is comparable to that of phenol. The cresol compounds leave sticky, gummy residues on surfaces and therefore surfaces must be washed after using these disinfectants.

5. Caustic (Sodium Hydroxide): Caustic solutions having a pH above 11.5 are often used to inactivate bacterial toxins such as botulinum toxin. Sodium hydroxide in a 2% solution can be used as a decontaminating agent against vegetative bacteria and as a 5% solution against bacterial spores. It is highly regarded by the Department of Agriculture as a practical decontaminant in veterinary research on infectious diseases of large animals. It has been reported that a 10% solution is effective against fungal spores. One of the chief disadvantages of using sodium hydroxide is that all surfaces become extremely slippery. For example, it is very difficult to grasp and hold a piece of glassware that is wet with sodium hydroxide. Caustic solutions are relatively non-corrosive to metals except aluminum, which is readily attacked. Most plastics are highly resistant to caustic, but oil base paints are rapidly and extensively damaged.

C. Vapors and Gases

1. Ethylene Oxide: At temperatures below 50°F (10°C) ethylene oxide is a liquid and is a strong solvent for organics. However, as a gas in a concentration of 300-500 mg/l no measurable damage to any equipment or materials has ever been noted. For example, an oscilloscope was carefully standardized and evaluated and then exposed to ethylene oxide gas for several days. No change whatsoever could be found in the oscilloscope due to this exposure. Ethylene oxide is a highly flammable gas that must be mixed with an inert gas such as carbon dioxide or the Freons to form a mixture that is non-flammable in all proportions when mixed with air.

Ethylene oxide is obtained commercially in a mixture having the following chemical composition by weight:

Ethylene oxide	- 12 per cent
Dichlorodifluoromethane	- 44 per cent
Trichlorofluoromethane	- 44 per cent

This non-flammable mixture usually is obtained in 16 oz. disposable cans of the aerosol type. The method for converting an autoclave for use with ethylene oxide in the 16 oz. disposable can is shown in Plate No. B.1. The 16 oz. quantity is sufficient to give a sterilizing concentration in small laboratory autoclaves. Several 16 oz. cans will be required in the larger autoclaves. This 12 per cent ethylene oxide mixture can be obtained in almost any larger sized, pressure type gas cylinder for use with large autocalves or use in central installed systems piped to autoclaves throughout a building. (There are two installed systems in laboratory buildings utilizing Carboxide (10% ethylene oxide with 90% carbon dioxide) in use at Fort Detrick. These systems utilize an expansion tank, a pressure reducing valve and piping to all autoclaves in the building.) All autoclaves equipped to use ethylene oxide gas for sterilization are piped to the building vacuum system. A vacuum of 18-20 inches of mercury is drawn on the autoclave before the ethylene oxide mixture is admitted. Generally, autoclaves are loaded in the late afternoon and allowed to stand overnight, giving a 16-18 hour exposure time.

Ethylene oxide gas has become an integral and universal method at Fort Detrick for the sterilization of electronic instruments, microscopes, heat labile plastics and all other materials and equipment that cannot be subjected to steam-heat. Some materials, especially rubber, will absorb ethylene oxide and release it slowly. Gas masks, rubber gloves, rubber shoes and other rubber items that contact the skin and have been sterilized with ethylene oxide must be thoroughly aired to prevent serious burn-like damage to the skin.

2. Formaldehyde: For more than 60 years, formaldehyde has been used as a space disinfectant. Many methods have been used to disperse formaldehyde in the air. Since formaldehyde is most effective at high relative humidities and elevated temperatures, steam vaporizers or steam ejectors are conveniently used to dispense the formaldehyde. Although beta-propiolactone has, to a large extent, supplanted formaldehyde for room and building decontamination, formaldehyde is still the decontaminant of choice for decontamination of filters, and some workers still prefer formaldehyde for room and building decontamination. For the treatment of small areas such as a Class I cabinet or incubator room a small insecticidal generator such as the Hydromist* generator can be used effectively. Many ventilated cabinets and building air exhaust filter plenums are equipped with permanent steam lines and steam ejectors for treatment of

* Tempo Industries, 1651 18th St., Santa Monica, Calif.

the cabinets or filters. About 1 cc of 37 per cent formaldehyde solution per cubic foot of space is used. In making this calculation, any airflow through the space must be taken into account and additional formaldehyde added to obtain the above concentration.

A modified smoke generator (M3A3) can be used to decontaminate buildings. Large amounts of formaldehyde can be disseminated in a short period of time with this equipment. In using either formaldehyde or BPL, the room or building need not be hermetically sealed, but all exterior doors and windows must be closed. Interior doors should be open to allow free passage of the vapor. Forced ventilation systems either should be shut off or airflow reduced to a minimum. Relative humidity should be above 70 per cent. This may be difficult to achieve in the wintertime without a central humidification system. Steam nozzles mounted in the building air supply plenum and operated for several hours are a satisfactory way to raise the relative humidity throughout a building.

If formaldehyde or BPL is to be used to decontaminate a building, provisions should be made to introduce the decontaminant at various locations. Each floor and each main hallway may need a supply point. A four inch pipe, sealed through the wall and capped at both ends when not in use, provides a suitable opening for introducing the decontaminating vapor. If the opening is at the second floor level or higher, a method for placing the smoke generator at this point must be provided.

Formaldehyde is a strong reducing agent and will react with many substances. It is non-corrosive to metals. It has a strong, pungent odor that can be detected at about 1 ppm. The maximum allowable concentration for prolonged exposure is 5 ppm. Formaldehyde is tremendously irritating to the eyes and mucous membranes at concentrations well below its toxic concentration. The one great difficulty experienced in using formaldehyde as a space decontaminant is its strong propensity to polymerize to paraformaldehyde. This compound releases formaldehyde gas slowly from a white crystalline stone-like compound that is only slightly soluble in cold water. Hot water, alkaline solutions or scraping with some instrument may be required to remove the paraformaldehyde. Three parts of methanol mixed with five parts of formalin solution will reduce polymerization. The method of dissemination and the amount disseminated per unit of space are the greatest factors in controlling the formation of paraformaldehyde. If the temperature of the space to be treated is above 75°F and the relative humidity is between 75 and 95 per cent, and if a high energy generator such as a smoke generator is used, no paraformaldehyde should be formed. In no instance should more than 1 cc of 37 per cent formaldehyde solution per cubic foot of air be used. Under carefully controlled conditions, formaldehyde is an entirely adequate space decontaminant. Aeration for a few hours, preferably overnight, should rid areas of formaldehyde vapors and allow re-entry and work within the treated area.

3. Beta-Propiolactone (BPL): The technique for disseminating BPL is similar to that for formaldehyde. BPL is superior to formaldehyde because polymers similar to paraformaldehyde are not formed and BPL is rapidly hydrolyzed when in dilute concentrations. Aeration for one or two hours is usually sufficient to allow re-entry into a treated area. The Challenger vaporizer, Model 510* is a suitable BPL generator for use in decontaminating rooms and small buildings. The modified M3A3 smoke generator is the most effective means available at the present time for delivering large quantities of vaporized BPL as in the treatment of entire buildings. One gallon of BPL per 16,000 cubic feet of space is used. As with formaldehyde the temperature should be above 70°F and the relative humidity above 70 per cent.

Some difficulties may be experienced in the use of BPL. Vapors of BPL are toxic upon inhalation and erythema and vesication may occur upon exposure of the skin to high vapor concentrations. Bulk BPL should be handled with the same precautions as a corrosive acid. It is most important to wear rubber gloves and rubber boots. A drop of liquid BPL spilled on leather shoes which are worn for several hours will result in severe skin damage that heals very slowly.

Beta-propiolactone is an extremely reactive chemical so that care should be taken to prevent contamination of BPL during storage. It is best to store BPL in the refrigerator. This greatly reduces polymerization. BPL is not in itself particularly corrosive to metals. However, BPL in dilute solutions rapidly hydrolyzes to hydroxypropionic acid, and BPL may react with other compounds to form amines, alcohols, mercaptans, acids, and water which may damage metals. Walls, ceilings, and floors should be dry and free of condensate when BPL is used. Vinyl floor tiles and paint of the oil base type will be severely damaged by BPL if droplets of the BPL are impinged on these surfaces. Therefore, a Kraft paper or similar covering should be placed over these surfaces near the BPL generator where droplets of BPL are likely to fall out.

4. Peracetic Acid: This decontaminating peracid has been extensively used in germ-free animal studies. The interior of air locks and the surfaces of containers being moved into the germ-free animal chamber are sterilized by spraying a mist of peracetic acid, usually in a 2% solution. At Fort Detrick, peracetic acid (2%) is used to sterilize the interior of cabinets, the interior of pass boxes, the surfaces of containers being moved through the air lock, and the outer surfaces of ventilated suits of workers leaving ventilated suit areas. The peracetic acid mist is set up with fog nozzles so that only a small amount is needed to sterilize pass boxes or ventilated suits.

Peracetic acid is highly efficient decontaminating agent, but is must be handled with great care. Peracetic acid is obtained as a

* Z & W Machine Products, Inc., 30242 Cleveland Blvd., Wyckliffe, Ohio

2/66

40% solution that also contains 5% hydrogen peroxide, 39% acetic acid and 1% sulfuric acid. On storage, peracetic acid slowly decomposes to molecular oxygen and acetic acid. At 30°C a loss of 1% per month of the peracid may be expected. At refrigeration temperatures this loss is greatly decreased. Great care must be exercised in handling the 40% peracetic acid. Temperatures of 70-80°C or contamination with heavy metal ions will cause an exothermic decomposition with a rapid rise in temperature which may result in a violent explosion. Peracetic acid vaporizes appreciably at temperatures above 50°C giving vapors that may be explosive. The flash point determined by the open cup method is 40°C. Once ignited, the solution continues to burn. Such a fire can be extinguished with water. The 40% peracetic acid should always be stored in the container in which it was shipped.

The 2% solution of peracetic acid in routine use as a decontaminant is non-flammable, non-toxic, and non-irritating to the skin. It produces a pungent odor that can be removed with ventilation or through spraying an alkaline solution. No residue remains after using peracetic acid. A 2% solution of peracetic acid gradually decomposes so that fresh solutions of 2% peracetic acid must be prepared at least once a week if held at room temperature.

Peracetic acid is a strong oxidizing agent and will attack many metals and other materials that are subject to oxidation. Glass, most plastics, aluminum, rubber, and stainless steel are unaffected by contact with 2% peracetic acid. Peracetic acid shower rooms for decontaminating ventilated suits should be lined with stainless steel and all piping, valves, spray-nozzles and other fixtures should be of stainless steel or plastic. The air exhaust duct from the peracetic acid shower room should be of stainless steel and a water scrubber should be installed to remove the corrosive peracetic acid vapors. The drain should be a sump type holding drain so that the liquids from showering can be well diluted with the wash water or neutralized with alkaline solutions before discharging to the building drain lines.

D. Ultraviolet Radiation

Ultraviolet radiation at 2537A is used in air locks and door barriers to isolate areas of differing levels of contamination within a building (see Plate No. 5.1). Ultraviolet, also, is used on animal cage racks to prevent animal cross-infection and to prevent escape of infectious aerosols from the cage, (see Plate No. 4.6). Ultraviolet is used in incubator and refrigerator rooms and may be used to reduce extraneous contamination in laboratory rooms. Shields and louvers have been designed to prevent excessive eye exposure to personnel working in areas where ultraviolet is in use (see Plates No. 4.7 and 4.9). Ozone generated by ultraviolet lamps is extremely reactive and will cause rapid deterioration in rubber, plastics, paint, and many other materials. However, in any area with even a small amount of ventilation ozone will be dissipated and will not be a problem. Ozone is considered to be toxic in a concen-

tration exceeding 0.1 ppm for an 8 hour exposure. Ultraviolet radiation will cause microscopic crazing of sheet plastics such as Plexiglass, which will then become cloudy when the irradiated surfaces are exposed to steam or other sources of moisture. In general, ventilated cabinets equipped with ultraviolet lights should either have reflectors to prevent the ultraviolet from shining on the plastic window or glass windows should be used. Ultraviolet will bleach oil-base type paints, and will accelerate the aging of vinyl plastics.

All surfaces in ultraviolet air locks and the interior surfaces of door barriers should be painted with aluminum paint to give good reflectance of ultraviolet. Aluminum is by far the best reflecting medium for germicidal U.V. The following table shows the per cent reflectance of U.V. radiation (2537A) from various surfaces.

TABLE B.1

Reflectance of U.V. From Various Surfaces
(Luckiesh & Taylor, 1946, J. Opt. Soc. Amer., 36, 227)

Material	Per Cent Reflectance of 2537A
Aluminum metal, etched and brightened	88
Aluminum metal, bright rolled	84
Aluminum metal, foil	73
Aluminum metal, Alzak-treated	65-75
Aluminum metal, mill	40-60
Aluminum paint	40-75
White-coat plaster	40-60
Chromium metal	45-55
Stainless steel	20-30
Wall paper (ivory and white)	21-31
Acoustic plaster and wallboard	10-20
Vitreous enamel	5-10
Kalsomine white water paint	12
Alabastine white water paint	10
Average oil paints	5-10
White porcelain enamel	4.7

Examination of the data presented in this table emphasizes several important points.

(1) Aluminum metals and aluminum paints are the best reflectors of U.V. energy. Intensive and prolonged exposure of aluminum paint does

not seem to destroy its ability to reflect the radiation.

(2) Stainless steel is a relatively poor reflector of U.V. energy. For maximum reflectance, reflectors made with stainless steel or any other metal except aluminum should be painted with aluminum paint.

(3) Oil paints and some water-soluble paints are poor reflectors of U.V. radiation. Reflectance depends upon the type of pigment in the paint; zinc oxide pigment usually gives low reflectivity. Oil paints usually give from 5 to 10 per cent reflectance, and water-soluble paints generally give from 10 to 12 per cent reflectance.

(4) White wall plaster has reflectance values of the order of 40 to 60 per cent for 2537A.

Alzak aluminum metal gives high reflectance values and is suitable for use as reflectors for U.V. lamps. Alzak is a trademark registered by the Aluminum Co. of America. The aluminum is first brightened by an electrolytic method to remove surface impurities and then treated to provide a thin coating of aluminum oxide to prevent weathering.

B-03 PREVENTIVE DECONTAMINATION

In all laboratories in which studies with infectious microorganisms are being conducted, decontamination of the laboratory or of areas in the laboratory such as the work bench, ventilated cabinet, or floor will be carried out at certain intervals. The decontamination may be accomplished after completing certain types of hazardous procedures, or decontamination may be carried out when agents are changed, whereas other laboratories may have a standard procedure of decontaminating at specified intervals. The design of the laboratory should take into account the fact that decontaminating solutions will be spread over most of the surfaces in the laboratory. The interior of ventilated cabinets, the tops of work benches, and the floor will be the areas most often subject to decontamination. Experience has shown that carbonized birch bench tops will not withstand washing at frequent intervals with decontaminating solutions. Steel storage cabinets must have continuous enamel coatings and they must be caulked or sealed to the wall and/or floor. Light fixtures, electrical switches, and convenience outlets in animal rooms and certain other rooms as specified in Section 5-02, ELECTRICAL, will be water proof. Certain specified laboratory rooms may have ultraviolet fixtures installed in the ceiling of the room which are turned on during periods of non-occupancy to reduce the general bacterial flora of the room. Control switches for these U.V. lamps will be located outside the laboratory room with a cobalt-blue indicator light.

All laboratory rooms may, on occasion, be decontaminated with beta-propiolactone. When this is done, the air supply to the room will be shut off. A convenient method of closing the louvers on the air supply grille should be available. The room must be maintained under a pronounced

reduced air pressure during the time that BPL is being disseminated into the room. The closing of the louvers on the air supply grille should be easily and quickly accomplished because the reason for decontaminating the room may be that an accident has occurred and a minimum exposure time for the individual preparing the room for decontamination is desirable. No other design features in the laboratory room are required to accomplish BPL decontamination, except that painted surfaces (wall, ceilings, etc.) should be resistant to BPL. Common oil-base paints are sometimes damaged by BPL droplets.

B-04 INSTALLED DECONTAMINATION SYSTEMS

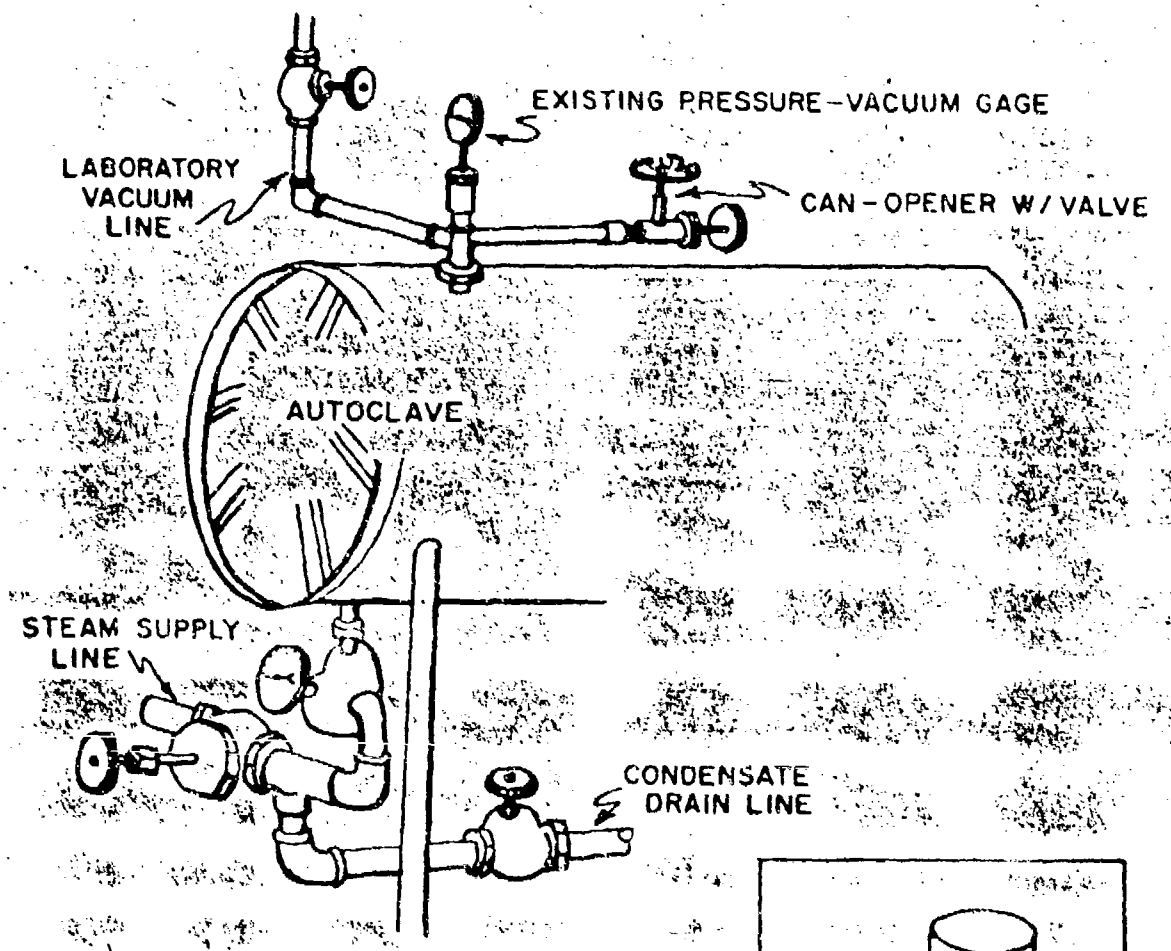
A. Piped Liquid Decontamination Systems

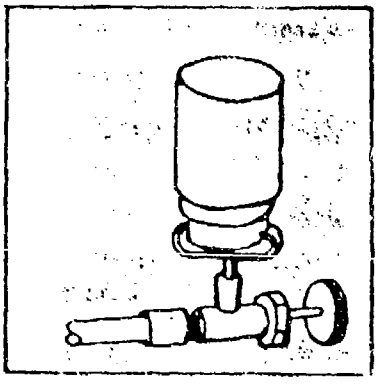
In certain buildings such as process development areas where large quantities of infectious materials are produced and processed, there may be a need for an installed decontamination system. Quaternary ammonium compounds such as Roccal or Hyamine 2389 in a 0.1% solution generally are used, although hypochlorite solution (about 5,000 ppm) might be used during operations with certain microorganisms. A tank of about 400 gal. capacity that is resistant to hypochlorite can be used as the decontaminant storage tank. This storage tank can be pressurized with air to about 60 psig, or a pump with recirculating bypass can be used, controlled from the laboratory or plant areas. The type of piped liquid decontamination system with various outlets and standpipes will be specified by the Government.

B. Piped Gaseous or Vapor Decontamination Systems

1. Steam-Formaldehyde: Ventilated cabinets, air exhaust plenums, certain rooms, and other enclosed spaces may require an installed steam-formaldehyde decontamination system. This system simply consists of a steam line that passes through a wall into the area to be treated; immediately before the steam line passes through the wall, a steam ejector of a suitable size is installed in the line. A valve is placed in the line before the steam ejector. A large air exhaust plenum may need a 40 psig steam line with a three-quarter inch steam ejector. A single ventilated cabinet may need a pressure reducing valve in the line to bring the steam pressure down to about 5 psig and a one-half inch steam ejector would be satisfactory. In operation, the steam is turned into the chamber to be treated until the relative humidity is raised to about 80%. Then formaldehyde solution is allowed to be drawn into the steam ejector and disseminated into the chamber. About 1 cc of 37% formaldehyde for each cubic foot of space plus 1 cc for each cubic foot of air being exhausted is injected. If a flowing air stream is being treated, then 1 cc of formaldehyde for each cubic foot of air being exhausted per minute is injected each minute for a 30-minute period.

2. Beta-Propiolactone: BPL can be used in the same manner as formaldehyde in the installed steam decontamination system except that 1 cc of BPL for each 4 cubic feet of space being treated is used. In general, formaldehyde is the preferred decontaminant for treating deep-bed, spun-glass (high-efficiency) filters.





FREON-ETHYLENE OXIDE CAN IN OPERATION POSITION

NOTE

A BAFFLE MUST BE INSTALLED WHERE THE GAS ENTERS THE CHAMBER. IN DOUBLE-DOOR AUTOCLAVES WHERE NO BAFFLE EXISTS, THE GAS MIXTURE MUST ENTER THE JACKET, NOT GO DIRECTLY INTO CHAMBER.

MODIFICATION OF AN AUTOCLAVE FOR USE WITH CANS OF FREON-ETHYLENE OXIDE	PLATE NO. B.1

2/66

APPENDIX C

PIPING MATERIAL GUIDE

1. General: The material included in the following Piping Material Guide is to be used as a guide only. The information will apply in the majority of cases but each application should be individually evaluated. An example of this is the question of substituting eccentric plug valves for diaphragm valves in contaminated drain (CCD), vent (CV), and contaminated water (CCW) lines.

2. Specifications and Standards

   a. Federal Specifications (use current edition)

GG-T-321	Thermometers; Industrial
HH-C-536	Compound; Plumbing-Fixture-Setting
HH-G-101	Gaskets; Metallic-Encased
HH-G-116	Gaskets; Plumbing-Fixture-Setting
HH-I-523	Insulation Block, Pipe Covering, and Cement, Thermal, Calcium Silicate (for Temperatures up to 1200°F)
HH-I-554	Insulation, Thermal, Magnesia: Block, Pipe, and Tubing
HH-I-561	Insulation, Thermal, Asbestos, Block and Pipe Covering (for Temperatures up to 750°F)
HH-I-562	Insulation, Thermal, Mineral Wool, Block or Board and Pipe Insulation (Molded Type)
HH-P-117	Packing; Jute, Twisted
QQ-L-156	Lead; Caulking
QQ-L-201	Lead Sheet
QQ-S-571	Solder: Lead Alloy, Tin Lead Alloy, and Tin Alloy; Flux Cored Ribbon and Wire, and Solid Form
SS-A-701	Asphalt-Primer; (for) Roofing and Waterproofing
SS-P-361	Pipe, Clay, Sewer
SS-R-451	Roof-Coating; Asphalt, Brushing-Consistency
TT-V-51	Varnish; Asphalt
WW-F-406	Flange-Dimensions, Standard: (Classes 125 and 250 Cast-Iron Flanges ; Classes 150, 250 and 300 Bronze Flanges) (for Land Use)
WW-H-171	Hangers and Supports, Pipe
WW-N-351	Nipples, Pipe Threaded
WW-P-351	Pipe; Brass, Seamless; Iron-Pipe-Size, Standard and Extra-Strong
WW-P-356	Pipe, Cast-Iron; Drainage, Vent, and Waste (Threaded)
WW-P-377	Pipe; Copper, Seamless, Standard
WW-P-401	Pipe and Pipe-Fittings; Soil, Cast-Iron
WW-P-404	Pipe, Steel, (Seamless and Welded, Black and Zinc-Coated (Galvanized)
WW-P-406	Pipe, Steel (Seamless and Welded) (for ordinary use)

WW-P-421 Pipe; Cast-Iron, Pressure (for Water and Other Liquids)
WW-P-441 Pipe, Wrought Iron (Welded, Black or Zinc-Coated)
WW-P-460 Pipe-Fittings; Brass or Bronze, (Screwed), 125-Pound and 250-Pound
WW-P-471 Pipe-Fittings: Bushings, Lock Nuts and Plugs; Brass or Bronze, Iron or Steel, and Aluminum; (Screwed); 125-150 Pounds
WW-P-491 Pipe-Fittings; Cast-Iron, Drainage
WW-P-501 Pipe-Fittings; Cast-Iron, Screwed 125-and 250-Pound
WW-P-521 Pipe-Fittings; Malleable Iron, Wrought Iron and Steel, (Screwed) 150-Pound
WW-P-541 Plumbing Fixtures, Land Use
WW-T-696 Traps, Steam, Thermostatic (for Land Use)
WW-T-700 Tube, Aluminum Alloy, Drawn and Seamless
WW-T-797 Tubes, Copper, Seamless, 6000 P.S.I. Maximum Pressure
WW-T-799 Tubing, Copper, Seamless (for use with Soldered or Flared Fittings)
WW-U-516 Unions; Brass or Bronze, 250-Pound
WW-U-531 Union, Pipe, Steel or Malleable Iron, Threaded Pipe Connection, 250 P.S.I. WSP: 500 P.S.I. WOG (Cold, Nonshock)
WW-V-51 Valves, Bronze, Angle, Check and Glove, 125-and 150-Pound, Screwed and Flanged (For Land Use)
WW-V 54 Valves, Bronze, Gate; 125-and 150 Pound; Screwed and Flanged (For Land Use)
WW-V-58 Valves, Cast-Iron, Gate; 125-and 150-Pound, Screwed and Flanged (For Land Use)
GGG-P-351 Pipe-Threads; Taper (American-National)

b. Military Specifications

MIL-A-3316 Coating, Fire Resistant, Adhesive
MIL-D-3156 Drains, Floor, Cast Iron
MIL-F-1183 Fittings, Tube Cast, Bronze, Silver Brazing
MIL-F-1224 Fittings, Brass or Bronze, Flared
MIL-F-23508 Fittings, Seamless and Flanges, Butt and Socket Welding Nickel-Chromium-Iron Alloy
MIL-P-1144 Pipe, Stainless Steel (Corrosion Resisting) Seamless or Welded
MIL-P-19119 Pipe, Plastic Rigid Unplasticized, High Impact Polyvinyl Chloride
MIL-V-13612 Valves, Relief, Temperature and Pressure Actuated

c. Hydraulic Institute Publication

Standards of Hydraulic Institute

d. American Society for Testing Materials

A-53-57T Specification for Welded and Seamless Steel Pipe
A-72-56T Specifications for Welded Wrought Iron Pipe
A-181-57T Specifications for Forged or Rolled Steel Pipe Flanges, Forged Fittings and Valves and Parts for General Service
A-234-57T Specification for Factory-Made Carbon Steel and Ferritic Alloy Steel Welding Fittings

e. American Standards Association

B 16.9-1951 Steel Butt Welding Fittings
B 16.10-1957 Face to Face and End to End Dimensions of Ferrous Valves
B 16.12-1953 Cast Iron Screwed Drainage Fittings
B 16.22-1955 Wrought Copper Bronze Solder Joint Fittings
B 18.2-1955 Square and Hexagon Bolts and Nuts

LINE SYMBOL	SERVICE	CONSTRUCTION	Pipe	Fittings	Unions	Shut-Off Valves	Throttling Valves	Check Valves	Strainers	Joints
110-S	110# Steam	2 " & Under, Screwed	1.02	2.03	4.03	6.05	7.05	8.04	9.02	5.03
		2½" & Above, Welded	1.01	2.01		6.01	7.01	8.01	9.01	Welded
40-S	40# Steam									
10-S	10# Steam	2 " & Under, Screwed	1.02	2.03	4.01	6.05	7.05	8.04	9.02	5.03
		2½" & Above, Welded	1.01	2.01		6.01	7.01	8.01	9.01	Welded
NHC	High Pressure Cond. 40 psig & Above (Non-Contaminated)	2 " & Under, Screwed	1.07	2.02	4.01	6.05	7.05	8.04	9.02	5.03
		2½" & Above, Welded	1.08	2.08		6.01	7.01	8.01	9.01	Welded
NLC	Low Pressure Cond. Below 40 psig (Non-Contaminated)									
CHC	High Pressure Cond. 40 psig & Above (Contaminated)	2 " & Under, Screwed	1.07	2.02	4.01	6.09	7.05	8.04	9.02	5.03
		2½" & Above, Welded	1.08	2.08		6.01	7.01	8.01	9.01	Welded
CLC	Low Pressure Cond. Below 40 psig (Contaminated)									
DW	Drinking Water	3/4" & Under	1.06	2.07	4.06	6.08				Solder
		1 " & Above	1.09	2.04	4.02	6.05				5.03
NCW	Cold Water (Non-Contaminated)	2 " & Under, Screwed	1.09	2.04	4.02	6.05	7.05	8.04	9.04	5.03
		2½" & Above, Welded	1.01	2.01		6.01	7.01	8.01	9.01	Welded
NHW	Hot Water (Non-Contaminated)									
NHWR	Hot Water Return (Non-Contaminated)									
DIW	Distilled Water	All sizes, Screwed	1.04	2.06	4.04	6.03	7.03	8.02		5.01 or
DMW	Deionized Water									5.05

3. Piping Schedule: The index numbers in the following tabulation refer to the specification details starting on page C.9.

LINE SYMBOL	SERVICE	CONSTRUCTION	Pipe	Fittings	Unions	Shut-Off Valves	Throttling Valves	Check Valves	Strainers	Joints
CCW	Cold Water (Contaminated)	2 " & Under, Screwed	1.09	2.04	4.02	6.09	7.05	8.04	9.04	5.03
		2½" & Above, Welded	1.01	2.01		6.01	7.01	8.01	9.01	Welded
CHW	Hot Water (Contaminated)									
CHWR	Hot Water Return (Contaminated)									
ACW	Air Conditioning Water	1½" & Under, Screwed	1.02	2.02	4.01	6.05	7.05	8.04	9.04	5.02
		2 " & Above, Welded	1.01	2.01		6.01	7.01	8.01	9.01	Welded
ACWR	Air Conditioning Water Return									
CA	Compressed Air	1½" & Under, Screwed	1.02	2.02	4.01	6.09	7.05	8.04	9.04	5.03
		2 " & Above, Welded	1.01	2.01		6.11	7.02	8.01	9.03	Welded
DCA	Dry Compressed Air									
PRA	Process Air	1½" & Under, Screwed	1.02	2.02	4.01	6.09	7.05	8.04	9.04	5.03
		2 " & Above, Welded	1.01	2.01		6.11	7.02	8.01	9.03	Welded
DPRA	Dry Process Air									
IA	Instrument Air	¼" & 3/8" Screwed Tubing Connectors	1.05	2.05	4.05	6.05			9.04	
		½" & Above, Screwed	1.03	2.04	4.02	6.05			9.04	
MA	Mask Air	1½" & Under, Screwed	1.02	2.02	4.01	6.05	7.05	8.03	9.04	5.03
		2 " & Above, Welded	1.01	2.01		6.02	7.02			Welded
PG	Propane Gas	1½" & Under, Screwed	1.02	2.02	4.01	6.04	7.04	8.03		Back-Welded
		2 " & Above, Welded	1.01	2.01		6.07	7.07	8.05		Welded
N	Nitrogen	1½" & Under, Screwed	1.02	2.02	4.01	6.09	7.05	8.04	9.04	Back-Welded
		2 " & Above, Welded	1.01	2.01		6.11	7.02	8.01	9.03	Welded

LINE SYMBOL	SERVICE	CONSTRUCTION	Pipe	Fittings	Unions	Shut-Off Valves	Throttling Valves	Check Valves	Strainers	Joints
NVA	Vacuum (Non-Contaminated)	1½" & Under, Screwed	1.02	2.02	4.01	6.04		8.03	9.02	5.03
		2 " & Above, Welded	1.01	2.01		6.07		8.05	9.01	Welded
CVA	Vacuum (Contaminated)	1½" & Under, Screwed	1.02	2.02	4.01	6.10		8.03	9.02	5.03
		2 " & Above, Welded	1.01	2.01		6.12		8.05	9.01	Welded
NCD	Drains (Non-Contaminated)	1½" & Under, Same as line served								
		2 " & Above, Welded	1.08	2.08		6.07	7.02	8.01		Welded
CCD	Drains, Exposed (Contaminated)	All Welded	1.08	2.08		6.12				Welded
CCD	Drains, Buried (Contaminated)	Bell and Spigot	1.13	2.09						Lead
NV	Vent (Non-Contaminated)	1½" & Under, Screwed	1.07	2.02	4.01	6.04	7.04	8.03		5.03
		2 " & Above, Welded	1.08	2.08		6.07	7.07	8.05		Welded
CV	Vent (Contaminated)	All Welded	1.08	2.08		6.10 6.12				5.03 Welded
CVI	Vent (Contaminated to Incinerator)	All Welded (See Sub-section 3-04 F.4)								
T	Decontaminant	1½" & Under, Screwed	1.02	2.02	4.01	6.04				5.03
		2 " & Above, Flanged	1.01	2.01		6.07				Welded
SA	Sterile Air	All Sizes	1.12			6.15				
MED	Slurry	All Sizes	1.12			6.15				

LINE SYMBOL	SERVICE	CONSTRUCTION	Pipe	Fittings	Unions	Shut-Off Valves	Throttling Valves	Check Valves	Strainers	Joints
HYD	Hydrolysate	All Sizes	1.10			6.15				
ACID	Acid	2 " & Under, Screwed	1.02			6.13				
		2½" & Above, Welded	1.01			6.14				
ALK	Alkali	2 " & Under, Screwed	1.02			6.13		8.03		
		2½" & Above, Welded	1.01			6.14		8.05		
CWS	Tower Water Supply									
CWR	Tower Water Return									
CWS	Cooling Water Supply									
CWR	Cooling Water Return	2 " & Under, Screwed	1.02			6.05		8.04		
TWS	Tempered Water Supply	2½" & Above, Welded	1.01			6.01		8.01		
TWR	Tempered Water Return									
RCWS	Refrigerated Water Supply									
RCWR	Refrigerated Water Return									
EG	Refrigerant-Ethylene Glycol	1½" & Under, Screwed	1.02			6.05		8.04		
		2 " & Above, Welded	1.01			6.01		8.01		
FRE	Refrigerant-Freon	5/8" & Under	1.11			6.16				
		7/8" & Above	1.06			6.17				
TCE	Refrigerant-Trichloroethylene	5/8" & Under, Flare	1.11			6.18				
		7/8" & Above, Sweat	1.06			6.18				
		1 " & Above, Screwed	1.02			6.18				5.04

NOTE NO. 1: All air, gas and vacuum lines may be silbrazed. Socket weld fittings.

NOTE NO. 2: Upon the approval of the Government, piping for cold and hot water, vacuum and air for connecting the horizontal service piping behind the laboratory benches to the service outlets may be copper tubing as described in item 1.06. The using agency shall be advised, however, that water transported through copper tubing may contain traces of copper which could interfere with bacterial growth.

NOTE NO. 3: Nipples for both steel and wrought iron pipe lines shall be extra strong wrought iron nipples.

(1) Piping and Tubing:

1.01 Schedule 40, butt or lap welded, Grade A black steel, ends beveled for welding. ASTM Spec. A-53, Fed. Spec. WW-P-406.

1.02 Schedule 40, butt or lap welded, Grade A black steel, ends threaded and coupled. ASTM Spec. A-53, Fed. Spec. WW-P-406.

1.03 Schedule 40, galvanized steel, hot dipped, ends threaded and coupled. ASTM Spec. A-120, Fed. Spec. WW-P-406.

1.04 Schedule 40, Aluminum type 3003-H18, ends threaded and coupled.

1.05 Seamless copper tubing, cold drawn, soft annealed with bright finish, ¼" and 3/8" O.D., 0.035" wall, ASTM-B68, Type DHP.

1.06 Seamless copper tubing type "K" Fed. Spec. WW-T-799. (Note: This selection for laboratory use requires using agency approval.) All copper tubing used in areas subject to washdown and decontamination procedures, shall be plastic coated.

1.07 Schedule 40, wrought iron, black, ends threaded and coupled. Fed. Spec. WW-P-441.

1.08 Schedule 40, wrought iron, black, ends beveled for welding. Fed. Spec. WW-P-441.

1.09 Schedule 40, wrought iron, galvanized, ends screwed and coupled. Fed. Spec. WW-P-441.

1.10 Glass pipe, pyrex type, double tough.

1.11 Seamless copper tubing, soft annealed with bright finish, dehydrated and sealed for refrigeration service, Type DHP, ASTM-B280.

1.12 Schedule 5S, type 347, stainless steel tubing, ends square for heliarc welding.

1.13 150-pound cast iron, bell and spigot joint, lead sealed.

(2) Fittings:

2.01 Schedule 40, seamless steel, butt welding.

2.02 150-pound malleable iron, screwed, black.

2.03 250-pound cast iron, screwed, black.

2.04 150-pound malleable iron, screwed, galvanized.

2.05 Seamless brass std. weight, compression type. Tees shall be wrought copper solder type.

2.06 Cast aluminum, std. screwed.

2.07 Cast bronze or wrought copper, solder joints.

2.08 Schedule 40, wrought iron welding fittings.

2.09 150-pound cast iron, bell and spigot joint, lead sealed.

(3) Flanges:

3.01 150-pound forged steel, slip on, ASA Spec. B16e..

(4) Unions:

4.01 150-pound malleable iron, screwed, ground joint.

4.02 150-pound galvanized hot dipped, screwed, ground joint.

4.03 300-pound malleable iron, screwed, ground joint.

4.04 150-pound cast aluminum, screwed ends.

4.05 Wrought copper solder type, standard weight.

4.06 Wrought copper, solder ends.

(5) Screwed Joint Treatment:

5.01 Alcoa anti-seize thread lubricant, or equal.

5.02 Red lead.

5.03 Key Graphite Paste, or equal.

5.04 Leak-Lok, insoluble in chlorinated hydrocarbons.

5.05 Teflon Tape.

(6) Gaskets:

5.10 Compressed asbestos - 1/16" thick.

(7) Bolts:

5.20 Carbon Steel machine bolts, sq. head with hex. nut - ASTM Spec. A-107. Nuts to conform to ASTM Spec. A-107.

5.21 Carbon steel stud bolts, threaded fill length, ASTM Spec. A-193-A. Grade B.C. with two carbon steel hex. nuts per bolt, ASTM Spec. A-194-45, Class 2.

(8) Gate, Diaphragm, and Plug Valves:

6.01 125-pound W.S.P. IBBM, solid wedge, flanged, O.S.&Y., Jenkins #651, or equal.

6.02 125-pound W.S.P. IBBM, solid wedge, flanged, N.R.S., Jenkins #326, or equal.

6.03 150-pound aluminum gate, screwed, Powell #1859, or equal.

6.04 125-pound all iron gate, solid wedge, screwed, N.R.S., Jenkins #97, or equal.

6.05 150-pound all bronze, solid wedge, screwed, Jenkins #670, or equal, see 6.06.

6.06 200-pound W.S.P. brass body, alloy steel trim, screwed, union bonnet. (May be used instead of 6.05 on water lines.)

6.07 125-pound all iron gate, solid wedge, flanged N.R.S. Jenkins #98, or equal.

6.08 150-pound brass gate, solder joints, renewable seat.

6.09 150-pound bronze eccentric plug valve, screwed, lever operated, "O" ring stem, seal, Teflon plug facing, DeZurik #104S or equal.

6.10 a. Saunders Weir type valve, ductile iron body, flexible diaphragm, screwed ends, ductile iron bonnet assemby, Grinnell or equal.

b. 150-pound semi-steel eccentric plug valve, screwed, lever operated, "O" ring stem seal, Teflon plug facing, DeZurik #102S or equal.

6.11 a. For use where steam is <u>not</u> available. 150 pound bronze eccentric plug valve, flanged, lever operated, "O" ring stem seal, DeZurik #103F or equal.

b. For use where steam is available. 125-pound IBBT solid wedge, flanged, N.R.S., with special steam seal bonnet, Crane #461 special or equal.

NOTE: Steam seal bonnet to be so constructed that any leakage around valve stem must go directly into the steam chest.

6.12 a. Saunders Weir type valve, cast steel body, flexible diaphragm, butt weld ends, ductile iron bonnet assembly, Grinnell or equal.

b. Choice. 150-pound semi-steel eccentric plug valve, flanged, lever operated, "O" ring stem seal, DeZurik, #101F or equal.

6.13 200-pound semi-steel, screwed, plug cock valve.

6.14 200-pound semi-steel, flanged, plug cock valve.

6.15 Diaphragm valve, Saunders patent, type 304 or 347 stainless steel body, high-temperature diaphragm.

6.16 Valve, S.A.E. flare fittings, diaphragm Freon type.

6.17 Valve, sealed bonnet type, sweat or weld ends.

6.18 100-pound bronze, nut tight gate valve, N.R.S.

(9) Globe Valves:

7.01 125-pound W.S.P., IBBM, flanged, O.S.&Y. Powell #241, or equal.

7.02 150-pound IBBM, flanged, inside screw, Powell #2188, or equal.

7.03 150-pound cast aluminum, screwed, Powell #1853, or equal.

7.04 150-pound all iron, screwed ends, inside screw, Powell #171, or equal.

7.05 125-pound W.S.P., all bronze, screwed, Powell #650, or equal, see 7.06.

7.06 200-pound W.S.P., brass body, alloy steel trim, screw union bonnet. (May be used instead of 7.05 on water lines.)

7.07 125-pound all iron, flanged, inside screw, Powell #493, or equal.

(10) Check Valves:

8.01 125-pound iron body, bronze trim, swing check, flanged Jenkins #624, or equal.

8.02 150-pound cast aluminum swing check, ends screwed, Powell #578 or equal.

8.03 125-pound W.S.P., all iron swing check, screwed, Powell #668, or equal.

8.04 125-pound all bronze swing check, screwed, Powell #578, or equal.

8.05 125-pound W.S.P., all iron swing check, flanged, Powell #1259, or equal.

(11) Strainers:

9.01 125-pound cast iron, flanged ends "Y" pattern.

9.02 125-pound cast iron, screwed ends "Y" pattern.

9.03 150-pound cast steel, flanged ends "Y" pattern.

9.04 150-pound bronze, screwed ends "Y" pattern.

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13. ABSTRACT

This two-volume series serves as guidance to management and to architects and engineers engaged in facility design at Fort Detrick. Volume II is intended primarily for use by the latter in designing new or modified microbiological facilities for Fort Detrick. It is divided into six sections, corresponding to the normal division of design work: architectural; heating, ventilation, and air-conditioning; piping; equipment and accessories; electrical; and instrumentation and controls. Each section is designed to be largely self-contained for the use of the individual specialists involved. A detailed Table of Contents, an alphabetical Subject Index, numerous illustrations, a Glossary, and supporting appendixes also are included.

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